Problem: Refluxing; Answer: Doughnut

Simple Solution Saves Steam

To recover heavy oil, the kind that's like molasses, heat it. The most common method of this "enhanced oil recovery" (EOR) is to continuously inject enough steam through a casing down the wellbore to soften the oil. In the oil patch, this method is referred to as "steam flooding" or "steam drive."

In addition, steam flooding may also prove to be the long-sought commercially feasible technique for recovering the light oil still remaining in "depleted" oil fields. Some two-thirds of the oil is still there, awaiting such a breakthrough. If the technique fulfills its current promise, it could have the effect of doubling the nation's light oil reserves.

But, whether the oil is heavy or light, simply using steam may not be the entire answer; a team led by Dan Aeschliman of GeoSystems Division 6256 has discovered that in "wet" wellbores — those drillholes that contain moisture — a substantial percentage of the steam's thermal energy is being wasted. And even dry wellbores become wet once the steam injection process begins.

The solution is simple — but more on that later.

"The rule of thumb is that you have to burn one barrel of oil to produce the steam to get three barrels out," says Dan. "That means a net of only two, which is pretty inefficient. We believe we've discovered a cause of significant loss of the thermal energy we're sending downhole, even when we're using insulated tubing." "Significant" here translates into, potentially, billions of dollars saved worldwide in the production of steam.

The cause of the heat losses is "wellbore refluxing" — a term that describes the loss of energy through uninsulated steel couplings between insulated tube sections and, from there, into the earth.

Refluxing is a conceptually simple — and very effective — heat transfer process that prevents large amounts of steam from reaching its downhole destination. It occurs when moisture contacts the outer surface of uninsulated, very hot couplings and flashes to steam. Steam clouds rise up the wellbore and eventually condense on the relatively cold well casing. As this occurs, the moisture gives up its heat to the surrounding rock formation. The condensed water then trickles down the casing or "rains" downward until it again comes in contact with a hot, uninsulated coupling and again flashes to steam.

"The oil extraction industry had never heard of refluxing," says Dan. "At first, we didn't suspect that the phenomenon occurs

(Continued on Page Four)

LAB NEWS

VOL. 37 NO. 9 SANDIA NATIONAL LABORATORIES MAY 10, 1985

Photonic Measurements

Not a New Instrument But a New Technology

A new approach to measuring high-speed data makes use of light instead of electricity. It's a fundamentally new technology for making physical measurements — one that could eventually come into wide use and allow measurements that are now difficult or impossible.

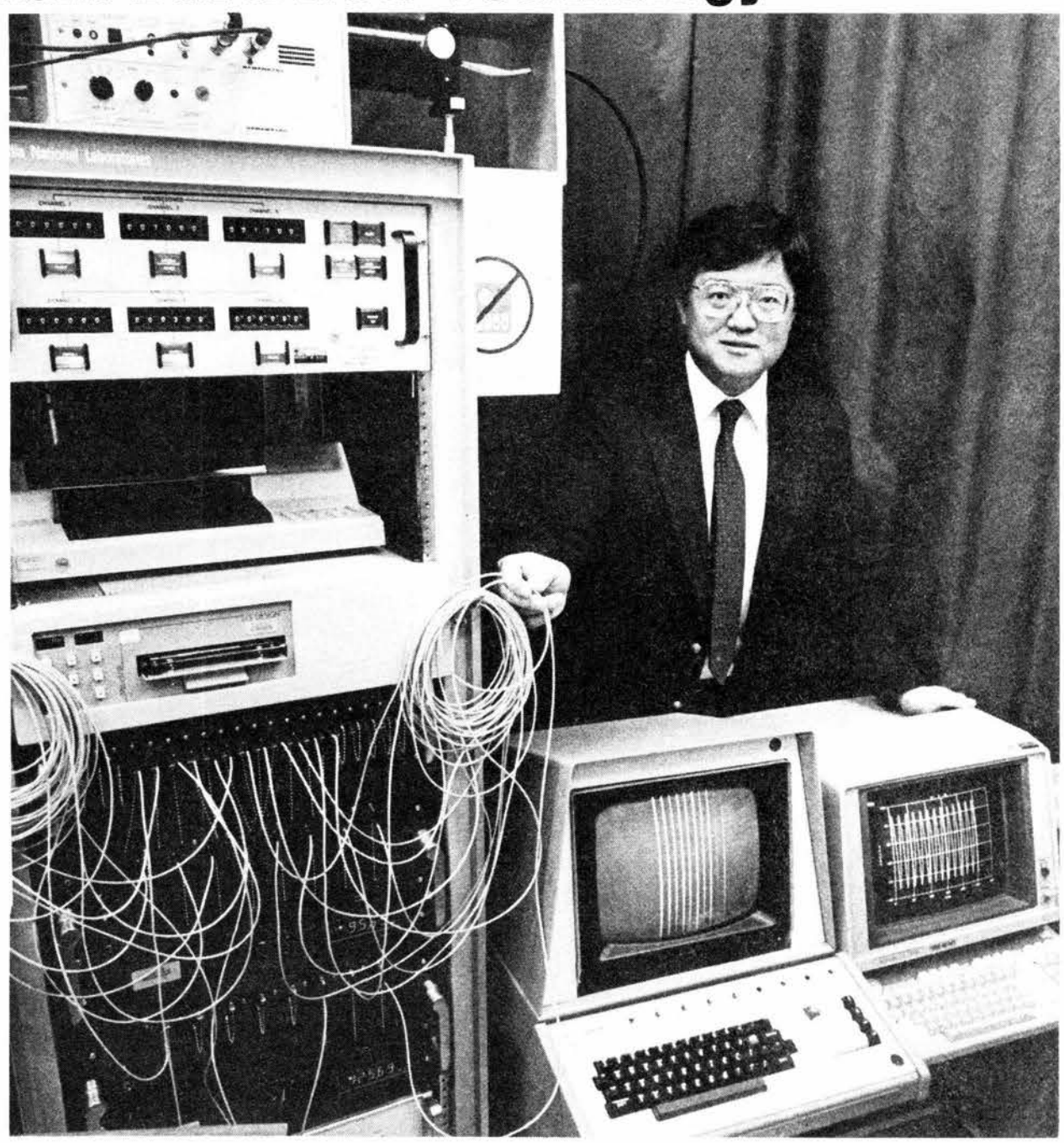
Measurement technology is a new aspect of photonics, so-called because it uses photons (the quantum of light energy), rather than electrons. Jim Chang, supervisor of Diagnostics Division 1234 and champion of this application of photonics, is one of many Sandians in several fields who believe that photonic measurement techniques have considerable promise in making physical measurements, especially where today's state-of-the-art electronic technology is very costly or difficult to implement.

"After all, we operate in a lab where we constantly need to make physical measurements," Jim says. "And there are only a few physical observables that can be measured — particles (electrons, ions, neutrons, photons, etc.), electromagnetic radiation (or waves), and momentum (including, on a microscopic scale, such phenomena as temperature, shock, etc.). That's all."

Conventional — that is, electronic — measurement systems have sensors that generate electrical signals. "Over the years a variety of sensors have been developed to measure these physical observables. The usual means is to generate analog electrical signals with a sensor, then transmit them through coaxial cables to oscilloscopes. The process can be cumbersome and costly.

"We all grew up using the oscilloscope, but it's an old technology — highly developed but with known limitations," notes

(Continued on Page Eight)



HEART OF this high-speed multi-channel data recorder (or "Husmucder") in Area IV is the streak camera in upper left. The prototype photonic measuring system transmits data via optical fibers, held by Jim Chang (1234) who headed the project team that developed the system. Such photonic systems promise major improvements, especially in terms of bandwidths greater than 1 gigahertz, over conventional electronic measuring systems.

Antojitos

National Science Week -- So What? "It's 10 p.m. Do you know where your kids are?" Well, next week is National Science Week 1985. Do you know where your kids are -- in terms of their science education? I suggest celebrating the occasion a bit differently this year: Adopt a teacher. That is, call up your kids' science teachers and really talk with them. Ask what their problems are in getting the subject across to their students. Share some ideas about how you and other parents could help them locate the resources they need to be better teachers. If you're an engineer or a scientist or a technician, offer to be a guest speaker in their classes. If you're not, volunteer to collar a Sandia compatriot and drag him/her to a class. In short, revitalize them as teachers by convincing them that what they are doing is important -- for your kids, for all the kids, for the future of the nation.

* * *

Thank You, Folks Who Publish the "Sandia Seminar" Announcements You managed to distract Sandia readers enough with your "His talk will include . . . antidotes from 20 years of building and flying spacecraft" that the errors in the last issue of LAB NEWS were hardly noticed. (We somehow managed to print "Grounding" for "Groundbreaking," "Captiol" for "Capitol," and "Liber" for "Lieber." Worse, when we asked the printer not to split "dubbed" -- couldn't have that in an issue where stupid word splits were the subject of the Antojitos -- the paragraph became one line longer and the printer just pasted the new line over the next line of the following paragraph, effectively consigning it to Perdition. I think that's someplace in Kansas.) Re: antidotes -- one of the Sandia Seminar readers suspected that "every time a sickening problem arose, they took a quick medicine, not unlike the snakebite stuff." Another noted, "I've worked here 20 years and could use an antidote too." Yes, the word ought to be "anecdote," a brief, often humorous story told to make a point. ●BH

* * *

Guide to Modern Science:

If it's green or it wriggles, it's biology.
It it stinks, it's chemistry.
If it doesn't work, it's physics.

Welcome

Albuquerque

Collins Clark (1235)
James McCoy (2313)

New Mexico

Dorthe Bame (323)
Daniel Carroll (6449)

Texas

Richard Costley (7552)

LAB NEWS

Published Fortnightly on Fridays

SANDIA NATIONAL LABORATORIES

An Equal Opportunity Employer

ALBUQUERQUE, NEW MEXICO
LIVERMORE, CALIFORNIA
TONOPAH, NEVADA
AMARILLO, TEXAS

Sandia National Laboratories is operated by Sandia Corporation, a subsidiary of AT&T Technologies, Inc., and a prime contractor to the U.S. Department of Energy.

BRUCE HAWKINSON, Editor
DON GRAHAM, Assistant Editor
NORMA TAYLOR, Writer
LOUIS ERNE, Photographer
GERSE MARTINEZ, Assistant Photographer
BARRY SCHRADER, Livermore Reporter

Member, International Association of Business Communicators

Congratulations

Stan (311) and Huri Fraley, a daughter, Cynthia, April 3.

Manuel (3426) and Mary Ann Prieto, a son, Marcus Joaquin, April 17.

Isabel (3426) and John Vigil, a son, John Joseph, April 28.

Bill Frix (5347) and Kaye Uszuko married in Albuquerque, April 20.

Riley (2567) and Alice Kilgo, a son, Sean, April 10.

ATTORNEY KURT OLSEN joined the Labs Legal Department 4010 on Feb. 15. He graduated from the University of Colorado at Boulder, and had been a patent attorney with AT&T Bell Laboratories at Murray Hill, N.J., since September 1979.

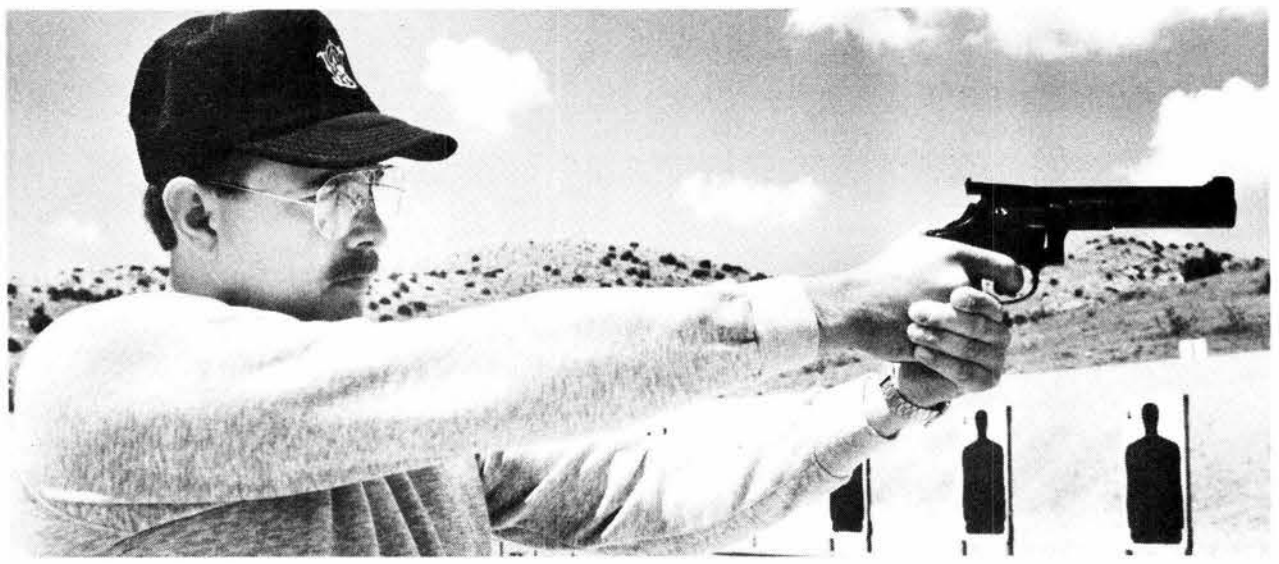
Annual Retiree Picnic Scheduled May 23

The 19th annual picnic for Sandia retirees will be held May 23 from 4 to 7 p.m. at the Coronado Club. Retirees now number approximately 2800 and live in 39 states and three foreign countries.

Videotape footage of last year's picnic will be shown in the Club dining room from 5 to 6 p.m.; footage from this year's picnic will be shown after 6. The Bob Banks Trio will begin to play at 5; Mike Michnovicz will also entertain. Members of Large Staff will join retirees and their spouses.

Parking space is available at the Club, the Chapel, the Que Pasa Recreation Center, and the Base Hospital. Handicapped parking is available in front of the main Club entrance. A shuttle bus will operate from the parking lots on "B" Street to and from the patio entrance. Security Guards will direct traffic. Please observe the "No Parking" along the streets in the residential area.

The Club will be closed all day on May 23. Doors will open at 3 p.m. for the picnic.



SANDIA SECURITY Pistol Team brought back 22 individual trophies from the National Rifle Association Pistol Tournament in Guymon, Okla., last month. Here, Inspector Keith Chavez (3435) shows the kind of determination that earned him six trophies and a Smith & Wesson handgun. A member of the South Force STOP team, Keith didn't do any shooting until he joined Sandia in 1982. He now practices eight hours a week, more before a match. "But it's 90 percent mental," he notes. Last year Keith was named DOE Security Inspector of the Year. Other members of the team are Captain Byron Gardner, Inspector Ernest Torres, Inspector James McQueary (all 3435), Inspector Ralph Garcia, and Lt. Louie Trujillo (both 3436). Their coach is Captain Harold Garcia (3435).

Analytical Tools for Metal Forming

Mini-Course on Codes Valuable

An intensive two-week mini-course designed to assist DOE weapons production agencies in the use of finite element computer codes to analyze metal forming was held recently at Sandia Livermore.

The idea for the course grew out of a discussion at a meeting of the Interagency Metal Forming Working Group. This group, originally organized by Materials and Processes Division 8316, consists of representatives of the national laboratories and production agencies.

"The production agencies are interested in developing a better analytical understanding of metal forming processes," says Joan Woodard, division supervisor. "At present most of these processes are designed empirically, which often results in expensive iterations. These computer codes will help in predicting what process parameters will lead to deleterious effects, such as shear-band formation and unsatisfactory residual stresses." The production agencies are also interested, for environmental reasons, in metal forming to near-net-shape in order to reduce the amount of waste material.

The course was designed and led by Bill Mason of Computational Mechanics Division 8245. Bill, with assistance from Vera Revelli, Structural Mechanics Division 8242, and Mike Chiesa, Solid Mechanics Division, 8241, presented the NIKE and DYNA finit element codes, and PATRAN, a commercially available pre- and post-processing code.

"The basic idea behind finite element codes is that a body of complex geometric shapes is subdivided into a series of simple shapes called elements." says Bill. "Within each element, the deformation of the body is approximated by simple formulas. The computer then combines the contributions of the individual elements to predict the overall behavior of the body. The result is a large system of algebraic equations. Solution of these equations provides a prediction of deformation, or change in the shape of the body. It also provides estimates of the changes that take place in the material properties, and of the stresses and strains thoughout the body."

The production agency representatives, Alberta Nielson of Rocky Flats, Gustavo Aramayo from Oak Ridge National Laboratory and currently working for the Y-12 plant, and Terry Jesperson of Bendix Kansas City, spent two weeks at Sandia studying and applying the computer codes. "We familiarized them with NIKE and DYNA, two of the computer codes available from the national labs. We also explained the capabilities of the codes and gave them an opportunity to apply the codes to some sample problems," says Bill. In addition, during one day of the two weeks, Elane Flower and John Hallquist of LLNL hosted the production agency representatives for a series of discussions on code development and application.

All three agency participants agreed the course was valuable. "I'm preparing to teach engineers to design with the graphics computers at Rocky Flats," said Alberta. "The course will enable me to add finite element codes to my lesson plans."

Gustavo, an engineer at Oak Ridge, does seismic analysis in support of the gas centrifuge and atomic vapor isotope separation process. The course will help him develop an analytical capability to apply to metal forming processes at Y-12.

Terry, an engineer from Bendix, works in the computer-aided engineering analysis area. His involvement is primarily with finite element and structural analysis. "We're interested in working with nonlinear codes, so learning about the NIKE code is a valuable experience." He plans to apply such codes to metal forming problems thoughout Bendix product groups.

Cathy Perkins from the Rocky Flats general metallurgy group attended two days of the course. Cathy hopes to use these codes in modeling metal forming processes.

Sandia expects that the course will provide the basis for a continuing relationship with the production agencies both in further training and in more development and refinement of Sandia's codes and materials models.

WORKING TOGETHER on the computer codes that will permit members of the production complex to solve metal-forming problems analytically are (left to right) Alberta Nielson of Rocky Flats, Gustavo Aramayo from Oak Ridge, Terry Jesperson of Bendix Kansas City, Bill Mason (8245), Vera Revelli (8242), and Mike Chiesa (8241). The three Sandians designed the mini-course.

SANDIA LIVERMORE NEWS

VOL. 37 NO. 9 SANDIA NATIONAL LABORATORIES MAY 10, 1985

Sympathy

To Arley Turner (8184) on the death of his father in Winton, Ca., April 19.

Take Note

The ambulance purchased by Sandia Livermore with DOE funds and transferred to LLNL for operation at both labs was recently helpful to a retired Sandian.

During periods when area commercial ambulances are in use, a mutual aid pact among the labs, Alameda County, and Valley public agencies provides for backup service.

Once such incident occurred late last month when the LLNL ambulance crew was summoned to a home in Livermore to transport a man to the hospital. He happened to be a retired Sandia employee, and the ambulance happened to be the one purchased last year through Sandia's efforts.

* * *

The board of directors of Associated Western Universities visited Sandia Livermore recently for a briefing by Vice-President Dick Claassen (8000). Representing 36 universities from the western U.S., they send faculty and graduate students to the national laboratories for summer research program work each year. Sandia has been a participant in the program for some 25 years.

Continued from Page One

Wellbore Refluxing Problem Solved

either. But we did know that the oil companies had no good way to judge the efficiency of the steam flooding process — all they knew was that it worked. They would design the steam flood based on the nominal insulated tubing properties and their knowledge of the oil reservior and overlying earth. Barring a catastrophe — the steam escaping from the injection well and erupting up the production well, for example — they might not change anything for years, assuming that they were doing as well as possible. They weren't.

"That's what we found when we got into the research that led to the discovery of refluxing," Dan continues. "Four years ago we were working with Husky Oil Company in Saskatchewan to measure the efficiency of insulated versus uninsulated tubing. We tried each type of tubing in the same hole, and we noted that the insulated tubing wasn't much better than uninsulated — we were losing much more heat into the earth than our calculations showed we should."

The Canadian experiments succeeded in providing oil field operators with the first long-term thermal performance data for insulated tubes in the field. "But we also discovered that, with the wellbore wet, the casing temperature was constant at the local boiling point of water, whether it was opposite low- or high-quality insulated tubing," says Dan.

"Now this finding was totally unexpected," Dan notes. "It implied that for the best tubing, the overall wellbore heat loss was up to six times higher than could be explained by tubing insulation performance characteristics and the earth thermal properties at the site. That effectively negated the economic argument for high-quality tubes" (see related story).

Subsequently, the project team conducted a series of tests during 1984 at a special research well in Area III. During experiments in this 122-foot-deep well, researchers carefully controlled operational parameters such as steam injection temperature, wellbore pressure, and moisture content. They used insulated tube sections joined by conventional couplings. Some experiments involved induced wellbore refluxing; other did not.

The Sandia tests suggested a relatively easy way to eliminate wellbore refluxing: insulate the tube section couplings. A two-inch-long, doughnut-shaped piece of plastic insulation (Teflon) placed around the inside wall of the coupling does it. The insulation keeps the steam that's traveling through the tubes from contacting the thin coupling walls and provides enough resistance to the flow of heat that water in the wellbore does not vaporize when it touches the couplings.

As a result of these tests, Dan notes, most tubing suppliers have begun to insulate their couplings.

CUTAWAY "DOUGHNUT" (white Teflon in center of tubing section) prevents wellbore refluxing by preventing loss of steam used to soften reserves of heavy oil. The phenomenon was recently discovered by Dan Aeschliman (6256) and Husky Oil Company's Bob Meldau with help from Roy Johnston (left), Jim Moreno, Tom Cabe, Don Hoke, Bill Vigil (now deceased), Dale Moritz, and Ramon Villegas.

"Refluxing is a self-sustaining, closed-loop process," says Henry Dodd, Dan's former supervisor. "Its impact on the steam injection process generally went unrecognized. One reason is that previous analyses of a wellbore heat loss have assumed a dry wellbore. If you make that assumption and use high-quality insulated tubing and uninsulated couplings, heat losses are minimal even down to 5000 feet.

"Second, because a refluxing wellbore is a closed-loop system, little occurs on the surface that would give EOR operators any indication that the wellbore is wet and subject to refluxing."

The US has about 100 billion barrels of heavy oil reserves; Canadian formations are estimated to contain about two trillion barrels, Venezuelan formations about three trillion. The US currently consumes about six billion barrels of oil a year, a third of which is imported.

"With only about 10 percent of US domestic production coming from EOR, and about 80 percent of that — or eight percent of the total — using steam as the recovery method, we're not talking about 'solving the energy crisis' by eliminating refluxing," Dan points out. "Nevertheless, my calculations show that the nation could save more than $1 billion over the next decade by using insulated couplings" (based on a formula that uses the present number of operating wells, present production rates and oil prices, and no inflation adjustment).

"But the real benefit may come in the future if, as now seems possible, steam flooding becomes widely used for oil recovery from now-depleted light oil reservoirs," Dan concludes. "Some 70 percent of the original oil in those reservoirs is still there, an inviting target for EOR. In general those reservoirs are deeper than the heavy oil pools now being tapped by using steam flooding; therefore, the problem of heat loss due to wellbore refluxing is much more critical for them. Stopping the refluxing process may ultimately make steam flooding of deep reservoirs feasible. If so, that would greatly increase — perhaps double — our oil reserves."

A Mystery & A Solution

Dan Aeschliman (6256) hadn't finished analyzing the data yet. So it was Husky's Oil Company's consulting field engineer, Bob Meldau, who first suggested in public that wellbore refluxing was rendering high-priced insulated tubing virtually worthless.

The occasion was a December 1982 summary conference of industry, university, and government labs people who were wrapping up Deep Steam, a Sandia-led project designed primarily to assess the technical feasibility of creating the steam for enhanced oil recovery (EOR) at the bottom of a drill hole rather than injecting it from a steam generator on the surface.

No one at the conference, except Bob and Dan, had even heard of the refluxing phenomenon. And Dan wasn't ready to risk his professional reputation by stating categorically that refluxing was the reason that low-quality insulated tubing performed as well as high-quality insulated tubing in most wells.

Therefore, Bob's statement was almost overlooked in the controversy about insulated tubing. It wasn't until later . . .

Some history first: The Deep Steam project, led by former Sandian Ron Fox, began in 1978. Although the project's main goal was to develop a downhole steam generator, there was also interest in trying to improve the efficiency of steam flooding using surface-generated steam. As part of the latter approach, Sandia arranged in 1980 to work with Husky to provide the industry with solid data on the field performance of insulated tubing, the kind that's necessary to move steam from the surface down to deposits of heavy oil and soften it for extraction.

Two other former Sandians, Don Johnson and Steve Eisenhawer, joined

(Continued on Next Page)

Workhorse Accelerator

HERMES II Fires 25,000th Shot

Recently, the 17-year-old HERMES II marked another milestone: one of the nation's largest gamma ray simulators was fired for its 25,000th time.

The giant accelerator is used principally for weapon effects testing but it also supports basic and applied research. The high-energy bursts of gamma rays produced by the machine simulate those of nuclear bursts. HERMES II is a primary source for testing transient radiation effects in electronics (TREEs). It is used in direct support of Trident II weapon system development, Sandia satellite systems development, Peacekeeper missile and warhead development programs, and other programs. It also supports tactical weapon systems development such as the M1 tank and the Multiple Launch Rocket System (MLRS).

"HERMES II is the most heavily used accelerator in the country," says Larry Choate, supervisor of Simulation Operations Division 1233. "We are booked solid for two years — about half of the schedule is for Sandia (Mk5 AF&F) and Lockheed Missiles and Space Company testing (D5 missile and post boost vehicle) in support of Trident II."

HERMES II operations crew invited the original facility operator — Jess Harness (ret.), left — back for the 25,000 shot celebration held at the facility recently. From left are Jess, facility supervisor Richard Westfall (1233), Joe Romero (MRL), Joe McGovern (Ktech), and Walker Simmons (USI). About 60 Sandians associated with the research and weapon effects testing conducted on the machine over the past 17 years attended the short ceremony.

The machine was renovated four years ago, and its 10 megavolt Marx generator was rebuilt. Last February the oil "farm" that stores the 150,000 gallons of mineral oil used as a dielectric in the machine was renovated.

"The remarkable thing about HERMES II," Larry says, "is that it was built back in 1968 with a design life of 1000 shots. It was the largest machine of its kind in the world at the time. It has proved to be one of the best bargains in research funding. We think it's good for another 25,000 shots, and we have users for it."

Wellbore Refluxing First Disregarded

Ron and the Husky drilling crew in the Aberfeldy field near Lloydminster in western Saskatchewan. The 1700-foot well, incorporating several Sandia-suggested modifications to aid in data collection, was completed in August 1980 ; instrumentation (thermal sensors attached to tubing sections) and data analysis, the Sandia tasks, began shortly thereafter.

Dan assumed responsibility for the project in March 1981. In addition to the other headaches typical of field experiments — 11 straight 16-hour days of hitching up instruments, then arriving home in Albuquerque to be greeted by a phone call announcing that a trencher had cut the buried instrumentation lines, for example — Dan was perplexed to discover that the well casing would get to the boiling point of water and stay there — without regard to the quality of the tubing used.

In May 82 the same experiment was repeated, this time with a wider variety of insulated tubing — high and low quality. Same inexplicable result: no real differences among the tubing varieties in terms of thermal performance.

"At that point Bob and I got down to some serious discussion," recalls Dan. "We agreed there had to be some sort of two-phase fluid and heat transfer process going on downhole, and we began to speculate about the possibility of refluxing" (see related story).

"At the time of the December 82 conference, I hadn't yet finished the calculations required to prove to my own satisfaction the existence of refluxing," Dan continues. "So I simply announced our anomalous finding — in the steam flooding process, the worst tubing on the lot will do as well as the best. That announcement, needless to say, was not exactly applauded by the makers of high-priced tubing.

"But Bob was willing to speculate in public. And he dropped our bombshell — that he felt we'd discovered a new phenomenon, wellbore refluxing.

"When the group turned to me for confirmation, all I could say was that I still had some homework to do; we couldn't prove the existence of refluxing as yet."

By March '83 Dan had finished those calculations and made his first public announcement of refluxing at the Society of Petroleum Engineers meeting. Word had naturally leaked out by then, and one of the tubing suppliers had arrived with handouts critical of the experiment on which the conclusion was based.

"The criticism contained some valid points," Dan notes. "We realized then that, if we were going to convince industry, we needed to conduct an experiment in which we could control the variables more precisely than we could in Saskatchewan. So that's when we decided to use our well in Area III. Here we could control temperatures, pressures, and moisture levels much more closely. Also, if we wanted to change something — pull the tubing string, for example — we could do it without impacting anyone else."

The Sandia experiment proved conclusively that wellbore refluxing exists, even in apparently "dry" wells (that is, wells with no obvious venting of water vapor at the surface). The experiment also confirmed the previous conclusion — that refluxing causes significant loss of thermal energy, and that a relatively simple and inexpensive (under $10) insulator could solve the problem.

In January 1985 DOE made a formal public announcement, based on Dan's current research and on his and Bob Meldau's prior work, to the industry. A month ago, Dan went to Bakersfield (where virtually all EOR using steam flooding in the US is concentrated) for the California Regional Society of Petroleum Engineers meeting and presented the results of the study to that group.

"This time, there were no criticisms, just the typical technical questions," Dan reports. "And the tubing suppliers were proudly showing off their insulated coupling designs in the exhibits pavilion. The last step in this process is to get the field operators to use what has now become available to them. That change may take a year or two, but I'm confident it will come."

Dan's experience with wellbore refluxing leads him to appreciate the role of the government R&D labs in developing the technologies necessary to exploit the nation's oil reserves: "I believe that it's important that a DOE lab, such as Sandia, be involved in fossil energy research, despite the existence of an excellent R&D capability within industry.

"First, it's appropriate for us to do longer-term, higher-risk kinds of research — in areas where the payoff is less certain, and therefore less attractive, to the companies themselves. They are searching for solutions to today's problems. If they do find something out of the ordinary but also out of the path of the current problem, they are often not in a position to be able to pursue it.

"Second, if the DOE labs discover something important, the entire country benefits. The part of Deep Steam that led to the discovery of, and a solution to, wellbore refluxing cost less than one million dollars total. It could not only return several thousand times that amount to the country in savings but also increase our reserves and reduce our dependence on foreign sources.

"And finally, because we represent no particular corporate viewpoint, we can be — and are generally perceived to be — objective. We hope that we have the respect of the industry as a whole."

Some History: Other Neat Solutions to Difficult Problems

The solution to wellbore refluxing has some illustrious predecessors at Sandia. Three earlier developments helped give Sandia a reputation for innovative and highly cost-effective "fixes" for technical problems.

The first was the laminar-flow clean room. Invented by Willis Whitfield in 1961, this clean room is swept by a uniform flow of filtered air that removes virtually all the airborne particles in the room. By the mid-60s, clean rooms and clean benches had revolutionized several industries, notably microelectronics fabrication and drug manufacture. Even hospital operating rooms used the concept. Clean rooms are now a $200 to $300 million a year business.

Willis went on to win the prestigious Holley Medal, also awarded to Henry Ford, Edwin Land (Polaroid camera); William Shockley (transistor), Carl Norden (bombsight), Harold Edgerton (strobe light), and Ernest Lawrence (cyclotron).

* * *

The second was the hot-air solder leveler, which revolutionized the fabrication of printed circuit boards (PCBs). Although using air as a leveler had been attempted for years, the air oxidized the solder. So PCB manufacturers had settled on a spray of hot oil as a leveler even though it tended to remove too much solder. In the early 70s, T.A. Allen (7484) and Bob Sylvester invented a hot-air solder leveler that worked — it used the hot air from specially designed "air knives" (or slots) to force the flux across the boards in such a way that the excess flux leveled the solder as it went.

The development effort cost less than $20,000, but since the new leveler went commercial in 1975, it has cut PCB processing time by 90 percent, pollution by 95 percent. It was a 1976 winner of an IR 100 award (making it one of the top 100 Industrial Research developments of the year). And it has spawned three new industries: one is the construction and sale of the machines themselves; that's now a $30 million a year business. The second is the solder coating service industry in the U.S. and overseas, which now amounts to some $50 to $120 million in sales in the U.S. alone. The third is the manufacturing and sales of chemical fluxes and cleaners for hot air leveling machines.

* * *

The third Sandia development is a systematically designed drag bit for the oil and gas drilling industry. Traditional rotary cone bits degrade during use because their bearings fail. This means frequent removal of the drill string for bit replacement, an expensive operation. An alternative is the drag bit, which has no rotating parts so no bearings. But on drag bits the cutting elements degrade. Synthetic diamonds, manufactured by General Electric, appeared to be tough enough to survive downhole. But the diamonds too often would not stay attached to the bit itself, the hydraulic interaction between cutting fluids (drilling muds) and the drag bit were poorly understood, and no one knew what the ideal placement of the diamonds should be.

In 1975 Sandia, working with GE and several drilling companies, began using computer codes to analyze and re-design the cutters and to determine the optimum placement of the diamonds. Sandia also went to diffusion bonding, rather than soldering or brazing, to hold the cutters securely in place during use. Field tests in the Valle Grande showed that the totally redesigned PDC (polycrystalline diamond compact) drag bit drilled four times faster than a rotary bit in the hot geothermal well with little degradation, verifying the design.

At the time, no bit manufacturers in the U.S. made PDC bits. But, since 1979, the success of the field tests catalyzed formation of several small companies and development activities in several large companies to produce similar bits. Currently every bit maker provides PDC bits, which have captured an estimated 20 to 30 percent of the bit market and have saved tens of million of dollars in drilling costs annually. The bits are used extensively for offshore drilling and, increasingly, for onland drilling in semi-hard rock. Sandia's development effort, led by Sam Varnado and Charles Huff, cost some $10 million.

* * *

There are several other Sandia inventions, such as TA-23 glass (which won an IR 100 award in 1984), that promise a significant economic impact, but the devices are too new for their importance to be measured. The corrosion-resistant glass, for example, has applications in virtually all lithium batteries and will clearly have a large impact in time.

Medical Corner

Co-Dependency—A Treatable Illness

by Lynne Judge (3330)

Being a co-dependent is tough, but help is available.

If you live with or are closely involved with an alcoholic or drug-addicted person, you're a co-dependent. And you're not alone: our society is crowded with co-dependents — spouses, children, and parents are most severely affected with the co-dependency syndrome, but relatives, friends, co-workers, bosses, social workers, the clergy, doctors, and anybody else who cares about a person who is alcoholic or drug addicted may also be affected.

Alcoholism/drug addiction is a baffling disease that initially affects its victims physiologically. But it also affects the victims emotionally, mentally, and spiritually. So the afflicted person behaves in unpredictable, baffling, bizarre, perhaps harmful ways.

Being close to an alcoholic or addict doesn't mean you're automatically enlightened about the cause of the disease: you may believe the alcoholic's/drug addict's behavior is caused by stress — or emotional instability — or moral weakness.

Most often, you believe you are somehow to blame. So, to survive, you begin to adapt — to change your behavior in response to the unpredictable and irrational behavior of your alcoholic/addict. Hoping to reduce stress, you take over responsibilities of the alcoholic/addict. You try to be on your best behavior — constantly, without relief — to avoid angering your alcoholic/addict or setting him or her off on another binge. That is, you try to please a person who cannot be pleased.

And there is a constant, running stream of guilt, worry, resentment, and self pity. Guilt — because you believe you somehow cause the alcoholic to drink or the addict to use. Worry — what will happen to the alcoholic/addict? what will he/she do next? what will happen to you, the co-dependent? Resentment — that the alcoholic/addict is drinking/using so much and is "getting away with" such outrageous behavior. Self-pity — that such a horrible thing could happen to you, the co-dependent.

It's not surprising that co-dependents suffer from a host of stress-related illnesses, allergies, high blood pressure, migraine headaches, colitis, ulcers, and many more. And these illnesses can escalate and become life threatening.

Co-dependents need help. They need education about the illness of alcoholism and drug addiction so they can learn that

LYNNE JUDGE

they did not cause it, can't control it, and can't cure it. And they often need therapy to learn healthier ways of behaving; to learn to let go of chronic feelings of guilt, worry, resentment, and self pity; to regain confidence and a sense of worth in themselves.

If you're a co-dependent, hope — and help — are available through Sandia. I'm the family counselor in the Alcoholism Program (3330), and I offer treatment to co-dependents, whether or not your alcoholic/addict seeks help. My phone is 4-3993.

Two Patents Awarded

VAWT Control Improved

Sandia's Vertical Axis Wind Turbine (VAWT) is one of the success stories of DOE's Wind Energy Program. The machine is in commercial production by several manufacturers, and a number of "wind farms" using the device are generating electrical power — Livermore Sandians are familiar with the Altamont Pass installation where more than 60 turbines are producing power for the Bay Area.

Nevertheless, improvements are possible — and forthcoming. A method to reduce the torque of the whirling blades during high winds has been awarded a patent, and another patent has been awarded for an additional braking device for the turbines. Both inventions reduce VAWT capital investment.

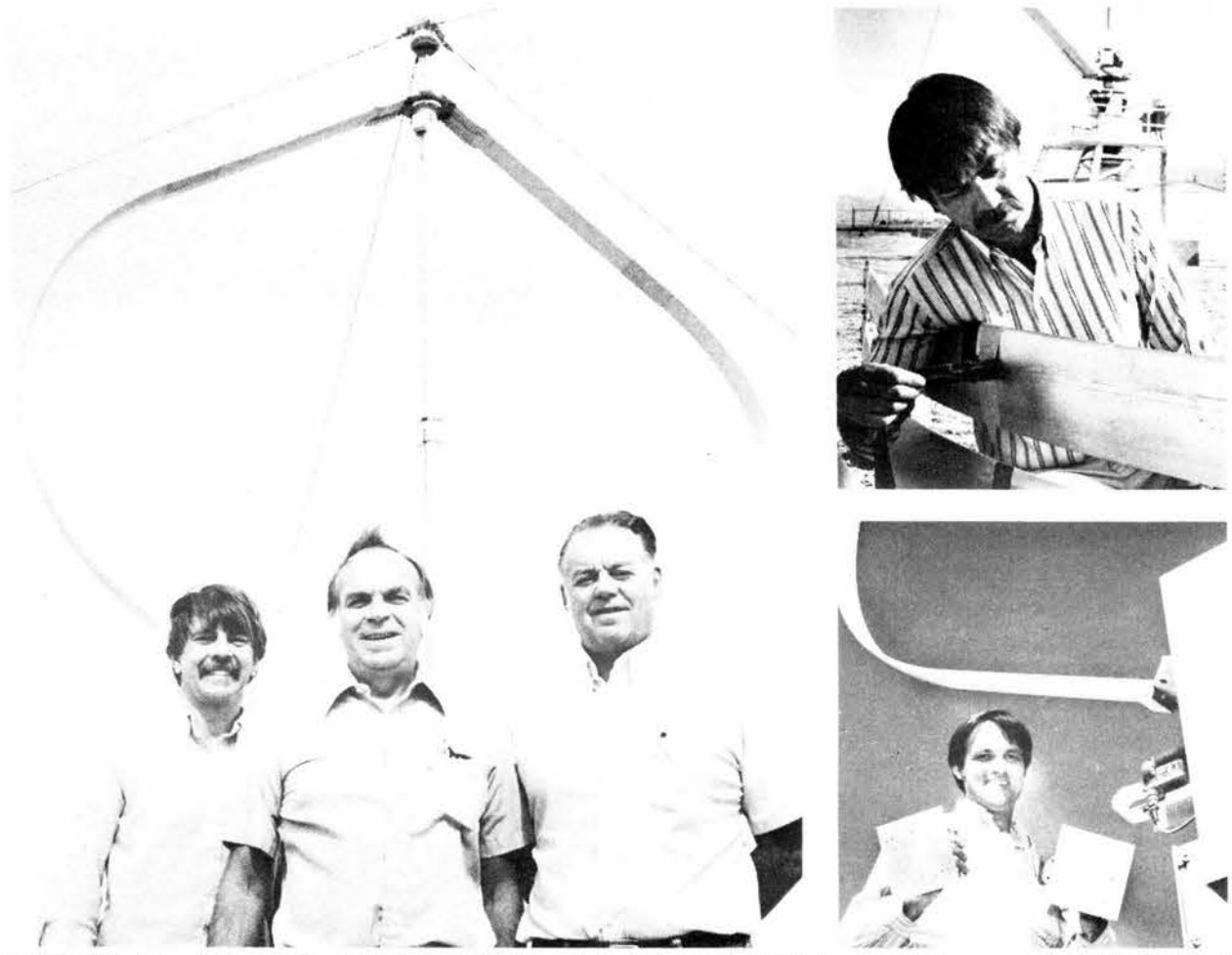
Inventors of a "jet spoiler arrangement" are Emil Kadlec and Paul Klimas of Wind Energy Research Division 6225 and Jack Cyrus of Exploratory Systems Division I 1621. Bill Sullivan, supervisor of Electromechanical Subsystems and Computer Aids Development Division 2542, invented a "wind turbine spoiler."

The jet spoiler permits the size (and capacity) of the generating equipment at the base of the VAWT system to be reduced.

Paul Klimas explains: "The VAWT is designed to produce power in winds from 12 to 45 mph. During normal operation, turbine output increases as wind speed increases until stall conditions are reached. [The blades of the VAWT are airfoils, similar to aircraft wings, and produce aerodynamic lift. The VAWT blades actually drive into the wind. They "stall" when angles of attack become large — lift decreases and drag increases. However, the stall occurs at very high speeds, thus necessitating large power equipment to handle the output from these infrequent gales.]

"The power generating equipment, which converts the torque of the spinning blades to electricity, is expensive. It becomes more expensive as its capacity is increased to accommodate the very high winds that generally do not occur a significant percentage of operational time to justify the additional costs. A great deal of capital investment money could be saved (resulting in a lower cost of energy) if the turbines wouldn't operate at higher wind speeds so that smaller generators could always be used."

The whirling VAWT blades act as a centrifugal pump — creating and enclosing an envelope of low pressure air. The new jet spoiler uses this difference in air pressure. A series of tiny holes (about the diameter of a toothpick) are drilled into both sides of the hollow aluminum VAWT blades. In normal operation the ends of the blades are closed at the connections, top and bottom, to the central VAWT shaft. There is no air flow through the blade ends. Opening valves at the ends of the blades during periods of high wind velocities allows the low pressure air to flow into the ends of the hollow blades and exit as high pressure air through the drilled holes. This "spoils" the aerodynamics of the blade.



INVENTORS Paul Klimas, Emil Kadlec (6225), and Jack Cyrus (1621) improved the control of the Vertical Axis Wind turbine (VAWT) with a jet spoiler addition to the hollow aluminum blades of the VAWT (shown in background). Paul Klimas gives us a closeup view of the matchstick-diameter holes, drilled in the blades, that spoil the aerodynamics of the whirling blades in high winds. Below right, Bill Sullivan (2542) displays another recently patented device — panels that automatically brake the VAWT in high winds. These are small scale versions of the devices built for testing on Sandia's 5-metre VAWT.

"Our tests show," Paul says, "that the holes have absolutely no effect on the blades in normal operation. The valve could be opened and closed with an automated control system linked to wind velocity. It is a simple and inexpensive solution that maintains generating efficiencies at low wind speeds while decreasing the loads on the generator during those rare times when very high winds occur."

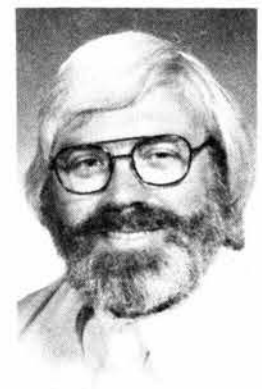
Bill Sullivan's patented device improves the mechanical VAWT braking system by creating additional aerodynamic drag. It is also simple and inexpensive. He uses two metal panels (about four feet square) positioned at the bottom of the blades. They are weighted and positioned not to interfere with normal operation. In very high winds, centrifugal force drives the vanes up to the equatorial center of the blades, producing aerodynamic drag that effectively slows the blades, ultimately bringing them to a complete stop.

"The VAWT is designed for unattended operation," Bill says. "There have been a few times during operation of the machines when the hydraulic braking system failed and the machine 'ran away' in high winds — the airfoil-shaped blades kept driving into the wind causing the turbine to go faster until the system failed. Because the hydraulics and braking system are subjected to long periods without maintenance, they are vulnerable to corrosion, rain damage, and dirt in the system. A very expensive quality assurance program could head off these problems, but one of our primary goals was to keep costs down. These wind spoiler panels require no maintenance or controls. They are an inexpensive emergency braking system."

Bob Grover and Joe Lackey (both 6225) contributed to the design and fabrication of the wind spoiler development.

Through Sandia's Technology Transfer Program, details on both inventions have been provided to VAWT manufacturers.

Bob Eagan Named VP of American Ceramic Society



Bob Eagan, manager of Chemistry and Ceramics Department 1840, was installed last week as a vice-president of the American Ceramic Society during its 87th Annual Meeting and Exposition in Cincinnati.

A Fellow of the Society, Bob is chairman of the membership committee; he has also served as chairman of the committee on publications and as secretary for the Ceramic Educational Council. He is a member of the National Institute of Ceramic Engineers.

Bob joined Sandia in 1971. His work has included the relation of physical properties of glass and glass ceramics to composition and structure, particularly the sealing of glass ceramics to metal.

Continued from Page One

Photonics: New Technology

Jim. "More modern digital oscilloscopes are better in many ways than the older ones, but they have problems in catching very fast signals and are very expensive."

The conventional process in a cathode-ray tube is based on, as Jim puts it, deflecting an electron beam in a vacuum. "But an electron has mass. So it has inertia, which ultimately limits the cathode ray tube's ability to record high speed electrical signals. Practically speaking, one gigahertz bandwidth has been the limit, and we've been at that limit since the 50s; it's a real stone wall."

An economical electronic means to break through that stone wall is highly unlikely, according to Jim: "It is very difficult to wiggle electrons accurately in subnanosecond time intervals." (A nanosecond is a billionth of a second.) Furthermore, in the transmission of high-frequency electrical signals through coaxial cables, energy is lost and the signal dispersed. Maintaining the frequency response requires a variety of compensations.

Also, the cathode ray tubes used to record the signals have their own limited response speeds. The electronic techniques necessary to overcome these problems are admittedly innovative but costly as well — an electronic recorder/digitizer to handle just one channel of data can cost more than $30,000. Experimenters at Sandia and elsewhere routinely use hundreds of channels, and they need far more. "The high cost and resulting scarcity of high-speed recording instruments are two of the most frustrating obstacles faced by experimenters," says Jim.

Jim and his project team — William Filter, Grant Lockwood, Barry Neyer, Gary Allen, Larry Ruggles, Parke Davis, Dave Muron, Clint Landron, and Chuck Martinez (all 1234) — believe the best way to measure physical characteristics is photonically.

With photonics, one begins with sensors that generate a light signal rather than an electrical signal. The sensors are chosen for their sensitivity to whatever is to be measured. They either produce light or modulate a light beam, and these photon analog signals — the data — are transmitted through optical fibers. Optical fibers' high bandwidth, low signal mass, and smaller bulk offer great advantages over coaxial cables (see "Photonics: A Primer"). They transmit the light to a high-speed multi-channel data recorder that's relatively low-cost.

"With analog photon signals, the photon that carries the information is what you measure," says Jim.

All parts of a photonic system are inherently high speed. Both sensors and recorder can respond on picosecond time scales. (A picosecond is a trillionth — 10^{-12} — of a second.)

Jim and his project team have developed and successfully applied a prototype Sandia High-Speed Multi-Channel Data Recorder (see "Husmucder" story) as a key component of a photonic measurement system. A variety of photonic sensors are also being developed. Using these novel photonic sensors, Sandia's photonics system has been used to measure the power and frequency distribution of high-powered microwave beams. "This technique of directly measuring a microwave spectrum and power is possible only because a photonic system is used," says Jim. "It has made a difficult measurement straightforward.

"And in the three years or so we've been working with photonics, the added performance and reduced cost of photonics systems have provided an entirely new dimension to measurement technology," says Jim. "We've already made quantized jumps, far beyond incremental gains, in our ability to make measurements. It's like going downhill on skis rather than snowshoes.

"Every time we have used photonic measuring techniques in another situation, we find it better than the conventional methods," he says. "We are really talking about a new technology base for making measurements — not just a new piece of instrumentation."

The only significant limitation to photonics measurements is that high radiation (in the tens to hundreds of kilorads range) makes the optical fibers "lossy," this is, lose their ability to transmit light.

It's also true, of course, that electronic measurement systems have become highly sophisticated over the years. The field of photonics is still in its infancy, but Jim fore-

'Husmucder': First Photonics Workhorse at Sandia

The key to the photonic approach envisioned at Sandia is a High Speed Multi-Channel Data Recorder (HSMCDR, sometimes pronounced "Husmucder"). It's a prototype photonic system, but it's already being applied widely in experiments conducted by the people in Pulsed Power Sciences 1200. These experiments have demonstrated its versatility, usefulness, simplicity, and superiority over conventional oscilloscope-based (electronic) systems.

HSMCDR was developed by a team led by Jim Chang (1234). It consists of a modern picosecond (trillionth of a second) streak camera, a digital readout system, and a data-handling microcomputer.

The photon analog signals are coupled into separate optical fibers. Their small size permits arranging many of them — 20 to 40 fibers — into a linear array for input through a lens into the HSMCDR's streak camera.

The streak camera is an electro-optic device that records these separate channels of data as separate vertical streaks. It translates a time-varying optical signal into a space-varying optical signal. For example, a signal consisting of six sequential pulses of light is converted into a streak exhibiting, from top to bottom, six variations of brightness. Each input fiber produces such a vertical streak; these are displayed side by side on a phosphor screen. A built-in television camera then converts the light streaks into digital form and sends the data into the computer system for processing.

The streak camera has a time resolution of 30 picoseconds, so an analog bandwidth (a measure of the information-carrying capacity of the system) of more than 5 gigahertz (GHz) is potentially available.

The entire prototype HSMCDR system, including streak camera and digitizer, control and monitor units, and computer, occupies only two instrument racks.

Jim says that recording high-speed multichannel data with photonic systems offers many advantages over conventional oscilloscope-based systems — economy, greater bandwidth (faster time response), higher channel density, compactness, and isolation from electrical interference. As a result photonic systems promise to overcome serious technical and economic obstacles that scientists face in recording voluminous data from transient events.

"When compared with conventional transient waveform digitizers," says Jim, "the HSMCDR shows a 6 to 1 reduction in cost per channel, a 10 to 1 reduction in space and utilization; a greater than 20 to 1 reduction in power consumption, and a greater than 20 to 1 reduction in installation cost. In addition, it is portable, has a 1-5 GHz bandwidth, and provides automatic time synchronization for all data channels."

The project team has used the system in several early applications, some active, some passive. An early active mode application, the first at Sandia, was to measure a powerful (hundreds of megawatts) microwave pulse. Most microwave sensors are designed to measure low wattages, so conventional sensors wouldn't work. The project team devised a system built around a bare electro-optic crystal the size of a sugar cube. The microwaves passing through the crystal modulated the polarized light of a laser beam introduced into the crystal by an optical fiber. The amount of the modulation allowed a measurement of the microwave energy.

By using a Fourier transform, the experimenters could also calculate the microwave spectrum; thus the photonics approach served as both a power meter and a spectroscope. It was the first demonstration that a photonics systems is actually capable, as theory predicted, of making a measurement greater than 3 GHz.

The first passive application was a proof-of-principle experiment to measure the output of a small pulsed electron beam accelerator. The team used a fast plastic scintillator, which emits optical photons in response to ionizing radiation, to monitor the current of the electron beam from the accelerator. The electrons caused the scintillator to emit light, which was transmitted by optical fibers to the HSMCDR.

sees a bright future. "Our work in photonic data recording has barely scratched the surface. Further research is necessary to ensure the ultimate success of this new approach. Our present effort focuses on developing a second generation HSMCDR that will double the number of channels, is smaller, and has higher precision."

One impediment to the field is a general lack of photonic equivalents of electronic components such as attenuators, splitters, inverters, and so on. There is as yet no "photonics industry" to supply them. Jim's group plans to replace the streak camera (which *is* electronic) with a photonic equivalent of the venerable cathode ray tube. And they are developing a technique to directly deflect signal-carrying light beams and record the deflected light beam on a reticon array. New sensors need to be developed. Yet all the *key* elements — lasers, streak cameras, computers, optical fibers, and bulk optical components — are already at hand.

"We find the possibilities exciting, and want to generate that same excitement in others," says Jim. "The synthesis and integration of these almost commonplace components can bring forth a new concept in diagnostics. We believe photon analog recording methods have the potential to extend and replace the analog electrical methods on which we have depended for so long."

Photonics: A Primer

Slip into a swimming pool. Swim to the bottom. Look straight up. You can see the sky through the clear water. Look up at an angle. You can see only reflections within the water.

The latter is an example of "total internal reflection." Discovered in the late 1800s, it's the principle upon which fiber optics is based.

That is, light can pass with little loss of quality from one end of a tube of pure water to the other (such a tube is more easily imagined than constructed) because the air/water interface provides total internal reflection. Contrast that with light reflected back and forth between a pair of parallel mirrors: within a few metres, the light has diminished significantly.

Total internal reflection is the phenomenon based on the differences in the index of refraction between two mediums — water and air, for example. The "dancing fountains" shows at some amusement parks and expositions rely on the phenomenon to create changing visual displays of water sprayed in patterns and lit from within. The light is trapped within the water by internal reflection off the boundary between water stream and air.

(Refraction refers to the change of direction that radiation, especially light or sound, experiences when it passes at an angle from one medium to another. It's analogous to a platoon marching across the boundary between a hard parade ground and a plowed field. If the line of march is perpendicular to the boundary line, the ranks of soldiers are simply slowed; but if the line of march is oblique, one end of each rank is slowed sooner than the other as it reaches the plowed ground and the line of march swings around toward the end that first contacted the softer surface.)

It wasn't until a couple of decades ago that researchers discovered that glass fibers with slightly different indexes of refraction could transmit light. The light (more precisely, the discrete packets, or photons, that transfer light energy) is trapped inside the inner fiber. But early fibers had so many impurities that the photons were scattered; most of the light energy was lost in a few metres of fiber.

By 1972, really pure glass fibers — impurities down in the parts per billion range — were being produced. Such fibers meant that light could be transmitted through a kilometre-length fiber with losses less than 10 percent. (The current goal in telecommunications is to produce fibers that can lead photons across an ocean with acceptable losses.)

Since 1972 has come the realization that a fiber has extremely high bandwidth. That translates into a high information-packing capability. That in turn makes fibers attractive to engineers who seek to break through the barrier of 1 GHz (a gigahertz equals a billion hertz, or cycles per second) that electronic means of data transmission seems to face. A single fiber today could routinely transmit some two million bits of data per second; that's a million times faster than the 2400 bits per second speed with which computers exchange information.

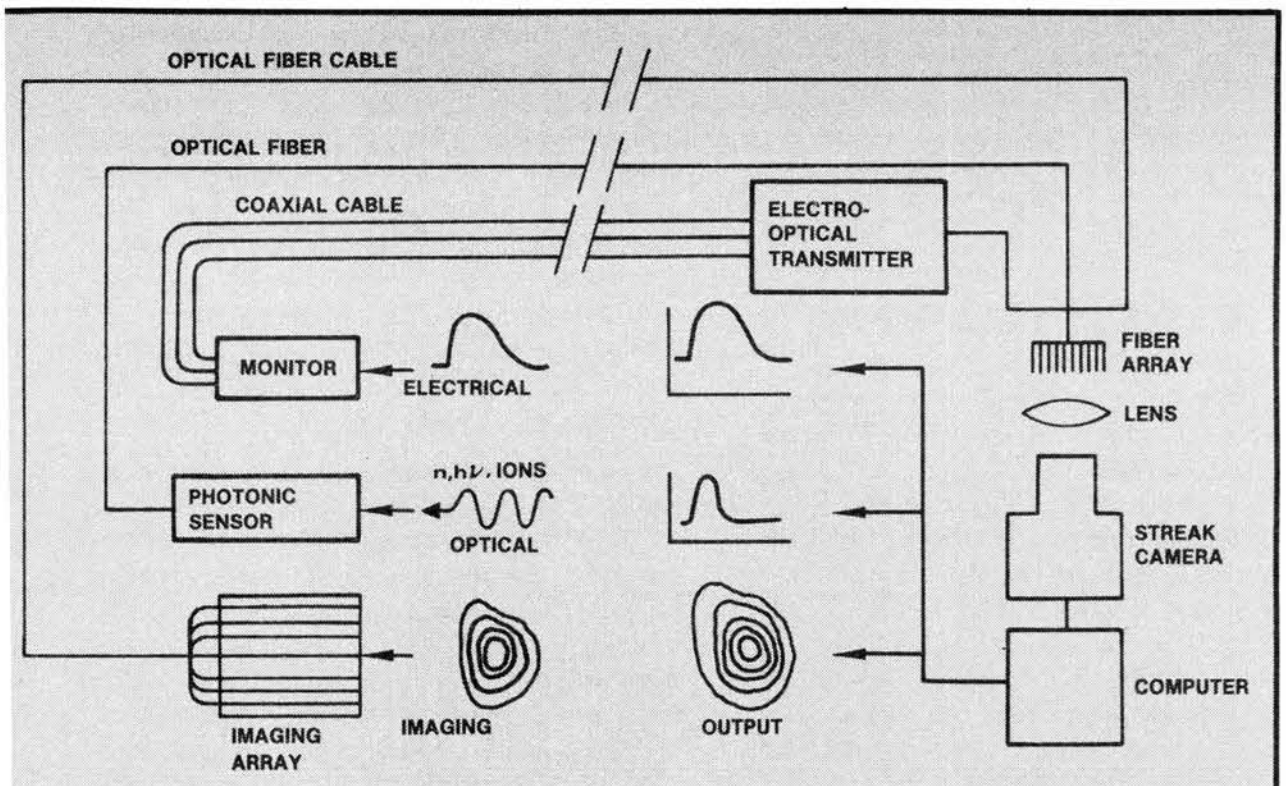
And fibers are tiny — typically around 125 microns in diameter (it takes 25 microns to equal 1/1000 inch). A multimode fiber has a 50-micron (diameter) optical fiber core surrounded by a 125-micron (diameter) optical fiber cladding (to provide the refraction difference that permits internal reflection) and a plastic jacket for protection against abrasion. Without the jacket, the entire fiber is thinner than a human hair.

Such characteristics make optical fibers and information transmission via photonics most attractive in telecommunications. "But telecommunications is just the tip of the iceberg," says Jim Chang (1234).

If Sandia has a philosopher of photonics, it's Jim: "Photonics represents a new technology, the 'next wave' in high-tech evolution that will create just as sweeping a change in our lives as has electronics."

The advantages are many, Jim points out. It takes little energy to transmit photons, so the technology is economical. Optical fibers are insulators, so they can be used where conductors can't function. They're tiny, so weight and volume are low

(Continued on Next Page)



SCHEMATIC of the "Husmucder" and the various ways it can be used to record photonic, electrical, and imaging signals.

The second experiment recorded the firing sequence of switches in large banks of high-voltage Marx generators. It was a challenging task. The Marxes are charged in parallel and discharged in series, producing high voltages. "Their switching sequence had never before been diagnosed in great detail," says Jim. "We used optical fibers to look directly at the flash of light created during a shot in the gas switches in each Marx bank. The photonics system provided precise data on sequence and 'jitter.' " (Jitter is the variation in time, measured in nanoseconds, that it takes for a switch to fire after shot time. Too much jitter and the pulse doesn't have the necessary concentration in terms of time.)

"Thanks to the photonic technique, the Marx generators have been modified, reducing jitter by a factor of two," Jim continues. "Also, because the current changes the polarization of the light transmitted, we were able to use optical fiber current sensors [which sense shifts in polarization] to verify that the light output is concurrent with the current flowing in the switches. This data in turn allowed us to correlate, for the first time, the current pulse with the light pulse in the switch.

"We installed the entire 30-fiber system in two days, and the third day got data," says Jim. "With coax cables and oscilloscopes, the same job would have taken us three months."

Symposium, Alliance Help Researchers

While the new technology of photonics is rapidly being adapted at Sandia and at other labs, it's important that researchers, users, and potential users communicate. Two such opportunities to exchange information are Sandia's Photonics Symposium and the Photonics Alliance.

The Photonics Symposium, held in April, provided Sandians in the technical directorates an opportunity to listen to more than 50 presentations on current work related to, or potentially related to, photonics.

Invited keynote speakers were George Sigel of the Naval Research Laboratory and James Ogle of LANL. Sigel spoke on fiber optic sensor technology and on ultralow-loss, infrared fiber optics, Ogle on fiber optics at Los Alamos.

In addition, a panel discussed the present status of photonics at Sandia, the shortcomings of the present status, the goals to be set, and how to attain the goals. Panelists were Roger Chaffin (1140), Glenn Kuswa (1601), Cliff Ballard (2531), Glen Otey (5160), and James Barham (8170); moderator was Mert Robertson (2531), who was also symposium chairman.

Mert reports that as many as 150 Sandians attended some sessions of the three-day symposium, held in the Technology Transfer Center. He notes that the keynote speakers were well-received and that a group of department managers and alternates is currently formulating a white paper on Sandia's use of photonics for consideration by Small Staff. The panel discussion and the papers presented will serve as an important input to the white paper. But perhaps most important is that the symposium created bridges between the various islands of users and potential users of the new technology.

The sessions included presentations on photonic sensors, communications, video, radiation effects, image processing, solid state photonics (including strained-layer superlattice applications), photonics instrumentation, and weapons-related photonics.

In addition to Mert, Chuck Barnes (1142), Jim Chang (1234), Norm Elliott (5347), Mike Gusinow (8175), and Fred Schow (2531) served on the program committee.

Complementing the local information exchange efforts is the Photonics Alliance founded by Jim Chang. The Alliance provides a means for photonics researchers at LLNL, LANL, the National Bureau of Standards, and Sandia (both Livermore and Albuquerque) to exchange information so that efforts don't get duplicated.

The group's first meeting was here in November 1984; its second was at LLNL in April 1985. In between meetings, the members keep each other — as well as researchers in universities and industry — informed about their work. For more information on the Photonics Alliance, call Jim at 4-1018.

Continued from Preceding Page

Photonics Primer

— and that makes installation easy.

"A single fiber can carry a million computer links simultaneously," Jim notes. "Imagine the size of a million wire pairs! And any copper wire is potentially an antenna for broadcasting or receiving. This makes wire subject to electromagnetic interference. A fiber is unaffected by such interference."

Below the telecommunications tip of the iceberg, Jim foresees using photons rather than electrons for measuring, monitoring, controlling, and processing information. And the measuring of high-speed data is the most advanced of the four at Sandia (see "Not a New Instrument..." story).

In spite of his enthusiasm, Jim's role as a philosopher advocating change is not easy: behavioral changes, attitude changes are every bit as difficult to bring about as technological changes. "But we're finding niches," Jim reports. "We're finding new and unique applications where we don't have to compete directly with electronic measuring tools. 'Filling a vacuum,' I call it. Most of those niches involve broadband — beyond the gigahertz — applications."

Sandia is certainly not the only lab to find the potential of photonics exciting. "We're taking a systems approach," Jim notes. "That is, we're developing a full range of photonic-based devices that sense, transmit, and record just as traditional scope-based systems do."

Potentially, the first major Sandia contribution to the growing field is likely to be the Photonic Data Recorder, which will be able to deflect, and thereby allow the measurement of, photons directly.

"We're in the forefront of developing such a recorder," Jim concludes. "But it's impossible to predict when we'll perfect it. We're still in the bootstrap stage — lots of mistakes, lots of learning."

How I Wrote a Book with Trabert

by Jim Hook (Ret.)

I was introduced to tennis in the summer of 1925 at a boys' camp in Denmark, Maine. A tall, slender, and rather shy young counselor, who turned out to be John D. Rockefeller III, gave me my first lesson. My game progressed surprisingly well, and I won the camp's medal for best tennis player. And in the years that followed I developed a fairly good game as a member of my high school team.

But at college I dropped tennis and took up golf. It was not until I was in my middle 40s that I took up tennis again. When I did, I was amazed to find I could beat many better players as much as 15 years my junior because I still had a good serve, the fundamentals of which I had picked up from tennis star Frank Shields (Brooke Shields' grandfather) when Frank and another tennis star, Sidney Wood, played for Roxbury School and I was playing at Taft.

After I retired from Sandia to try my hand at writing, one of my projects was to collect and organize my thoughts about the tennis serve. In the wake of doing so, I ended up with enough material to write a 40,000 word book-length manuscript. I submitted a draft to several large New York publishing houses. They all commented favorably on the idea for the book and the way it was written, but they advised that its unknown author would make the book too difficult to market to warrant publication.

Several years later a friend arranged for me to show the manuscript to tennis stars Bill Talbert, Jack Kramer, Ellsworth Vines, and Tony Trabert. All of them liked what they saw — Tony in particular. Later Tony and I decided to co-author a finished book on the tennis serve: Tony would furnish the technical data, I'd do the analytical work.

We soon found that working 800 miles apart (Tony lived in Palm Springs at the time) was no cup of tea. Tony's peripatetic schedule didn't make things any easier: his work as non-playing captain of the US Davis Cup Team, tennis commentator with Pat Summerall on CBS-TV, and conductor of tennis clinics at various conventions all over the world had him jumping from one place to another inside and outside the USA and made it difficult for me to keep in touch.

But the inter-author chemistry was good. After three meetings and several phone calls the manuscript was ready for print.

This time, the search for a major publisher was relatively short. The editors at the first one contacted wanted to accept the manuscript, but they were overruled by a management review board that had had bad luck with a tennis book the previous year. The second publisher also liked the manuscript but wanted to expand it into a "how-to" atlas covering all tennis strokes.

The third publisher contacted was Dodd, Mead. The firm was enthusiastic about the manuscript from the start and offered a contract and advance in short order.

Another 12 months were to pass, however, before the book was actually published in November 1984. And what a year it was. As I look back on it now, the negotiation effort involved in settling on the final format, page size, print, wording, use of drawings and photographs, etc.—with me mediating between a hard-to-reach co-author on the West Coast and a slow-to-communicate editor on the East Coast—was the single most challenging task I had undertaken since I worked in New York City as a copywriter for J. Walter Thompson 50 years ago.

Do I plan to tackle another book? As I close on my 73rd birthday, I have to answer, "Probably not." One thing for sure, though: if I do take on another major writing assignment, I'll do it by myself and stick to simple fiction with no illustrations and no need to parry and thrust with an editor whose blue penciling can often be meaningless when the editor possesses only a shallow familiarity with the technical points of a non-fiction book's subject matter.

Ed. Note: Jim's and Tony's book, The Serve: Key to Winning Tennis, *is described in the Take Note section of this issue. It's available in paperback in the LAB NEWS office.*

Most Comprehensive in US

SIMS Evaluates Intrusion Detectors

Banks have them. Many warehouses have them. Nuclear reactor sites have them. Even some houses have them.

They're intrusion detectors, designed to alert the Good Folks if the Bad Folks are trespassing. But no one, not even the manufacturers of the detectors, really knew how well they worked. Until SIMS.

SIMS is the Sandia Intruder Motion Simulator. For the first time anywhere, intrusion detectors can be placed in one of two test devices within an environmental chamber the size of a large closet, subjected to repeatable tests, and measured against a large (and growing) data base containing thousands of records — the precise responses of a given detector to a given threat under a variety of environmental conditions.

"Intrusion detectors have been around for as long as people have needed protection for themselves and their possessions," says Bob Workhoven; he's a member of Intrusion Detection Systems Technology Division 5261 and leader of the project team that developed the SIMS system. "Our ancestors relied on the barking of dogs or the snapping of twigs to alert them that someone was intruding into their territory.

"But it's hard to calibrate a dog. Dogs may bark at your daughter one night and sleep through a thief's visit the next. And even modern, 'sophisticated' alarm systems have similar problems. We find variations in the sensitivity of even the same models by the same manufacturer."

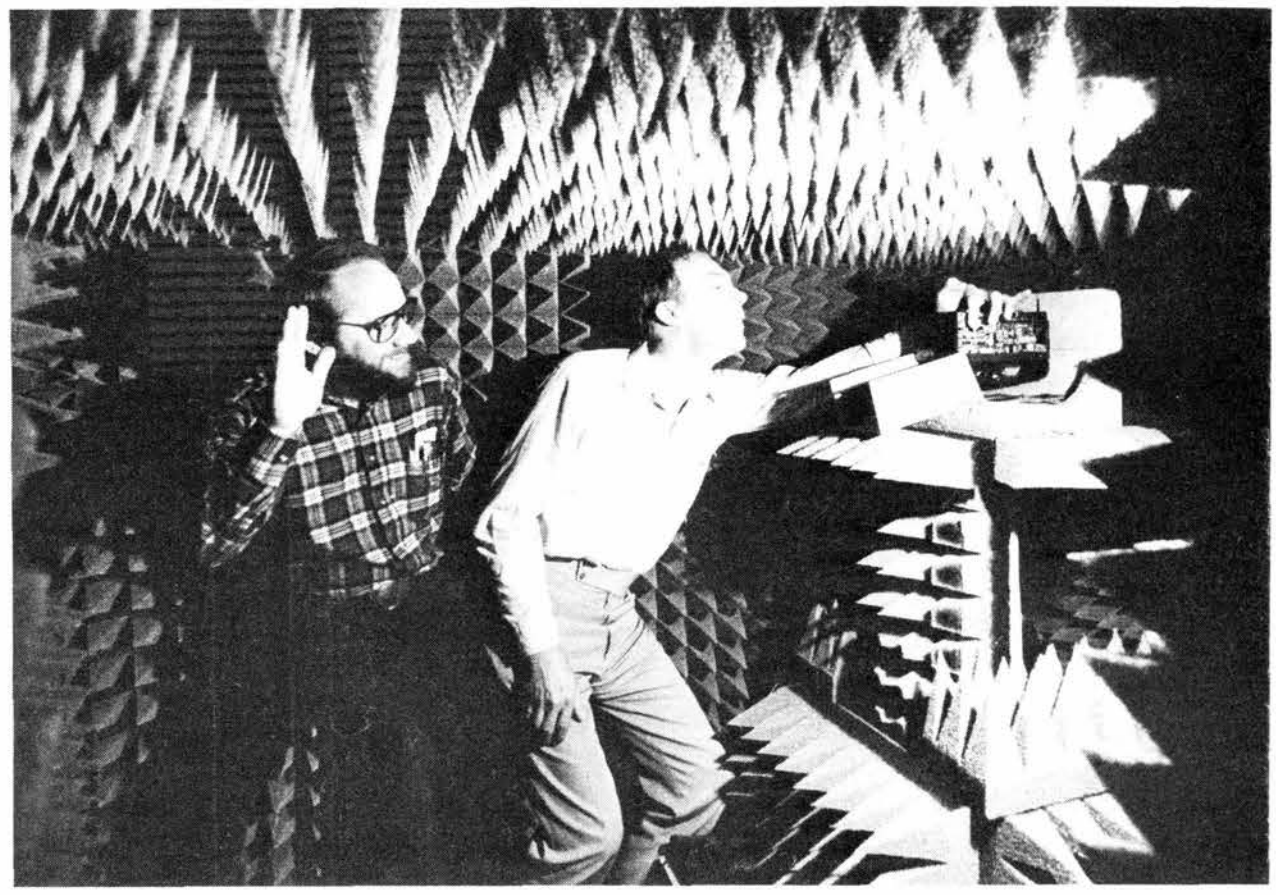
Among the many types of intrusion detectors, motion sensors are the most complex and, therefore, most difficult to evaluate. SIMS can test several types of intrusion detectors, but its capability to evaluate motion sensors is outstanding.

Motion sensors have traditionally been tested by almost primitive means: you intrude, and then you try to quantify what it takes to make a sensor sound an alarm. That is, you set up the sensor, then walk or run back and forth in front of it and record its responses. That's what the manufacturers do, and for much of the 10 years that Sandia has been evaluating sensors, that's what Sandia has done. You can still see the yellow tape on the floors of the 5261 laboratory to show where the human guinea pigs or the motorized mannequins have walked (or rolled).

"When walk tests are conducted with more than one person, results can be jeopardized because of size and body motion differences," says Dick Sons (also 5261), a member of the project team. "In fact, just how a person swings his or her arms can affect a detector's response. Different colors of clothing and different body metabolisms also can influence results. Repeatable results are almost impossible."

SIMS has changed that — for the better. It comprises the most comprehensive motion detection evaluation facilities in the US and allows the project team to gather the most detailed data yet available about the performance and reliability of intrusion detectors.

SIMS tests thoroughly characterize a sensor's performance; they provide precise details about its field of view, sensitivity to temperature and humidity extremes, sensitivity to distance of the intruder from the sensor, and sensitivity to intruder velocity.



ADJUSTING THE ACTIVE intruder motion simulator are Bob Hufnagel (left) of EG&G and Dick Sons (5249). Both are members of the SIMS (Sandia Intruder Motion Simulator) project team. Bob's not waving — he's checking the response of the ultrasonic sensor that Dick's adjusting. Foam rubber cones provide a reflection-free chamber.

SIMS can test both passive and active motion sensors. One passive motion sensor recognizes temperature variations — the warm body of an intruder, for instance — within its field of view.

Active motion sensors transmit signals — microwaves or ultrasonic waves, for instance — that return to the device after bouncing back from objects. An intruder in a room noticeably alters the return signal.

The passive simulator tests infrared motion sensors, which rely on their ability to differentiate between the body heat of an intruder and the heat present in the site itself. It's a semi-circular device about five feet in diameter and about two feet high. A sensor being tested sits at the center point of the simulator. The target (a heated rectangular plate attached to the tip of a motorized arm and designed to simulate a moving body) travels back and forth along the simulator's circumference. Speeds range from one inch a second (equivalent to an intruder walking slowly through a room) to 15 feet a second (a rapid run). The target size, variable from 18" x 3" to 1½" x ¼", simulates real-life distances from the sensor of 9 to 100 feet. Researchers can vary the temperature differential between the target and the rest of the simulator from less than 0.5°C to 20°C.

The active simulator tests the ability of a sensor to respond to variations in the signals returned to it. During tests, researchers aim a microwave or ultrasonic sensor toward an instrumented panel located about six feet away. Upon receiving this signal, the panel retransmits a different signal to the sensor — the same kind of signal that would occur if an intruder passed in front of the sensor. By varying this return signal's frequency and/or power, the simulator can reproduce different types of intruder movements and distances from the sensor. Field of view is determined by rotating the sensor slightly during tests.

Both simulators are housed in an environmental chamber that can subject the simulators to temperatures from -50°C to 80°C and to relative humidities from 20-95 percent.

"Although motion sensors are intended primarily for interior installation, many of the buildings that need protection are warehouses or bunkers that lack environmental control," says Bob. "Therefore, sensors must be tested over a wide range of environmental conditions."

"The unique capabilities of SIMS allow us to simulate the likely environmental extremes at specific facilities where sensors are being installed or changed," says Dick. "This, in turn, gives the sensor manufacturer and user a pretty clear idea as to whether a particular device is likely to perform well at a particular site. We've seen situations where a sensor might be recommended for one site, but not for another.

"For example, a building with high velocity air passing through it — for temperature or humidity control, say — is a poor candidate for an ultrasonic sensor, which is likely to respond to the motion of rushing air."

"Another advantage of SIMS is that it's computer controlled," points out Bob Hufnagel of EG&G; he assisted David Jones (5261), who designed and built SIMS, and now runs most of the tests. "That means tests can go on during non-working hours and that data on sensor performance can easily be recorded and retrieved. We're developing the nation's definitive library of sensor capabilities for physical security applications by the DOE and other government agencies."

Fjords For a Fjordnight

Peripatetic Ed Neidel (2361) is at it again. Last summer's vacation took him on an 8060-mile odyssey through Scandinavia and parts of Northern Europe. If a distance of more than 8000 miles is too much to comprehend, imagine traveling from New York City to Los Angeles to Seattle, back across the country to Boston, and down to Birmingham, Ala.

Using Eurail passes, Ed, his wife Lu, Dick (ret.) and Betty Othmer, and Bob and Sandy McKay covered the distance in four weeks, about half in fjord country.

"The Eurail pass is really a bargain if you want to cover long distances," Ed says. "First-class passes were $410 each. If we'd bought individual tickets for all parts of the trip, the cost would have been almost double. And with the passes, we didn't have to stand in line at ticket windows in railroad stations."

Their odyssey began with a flight from Albuquerque to Frankfurt. From there, they caught a train and headed to Brussels. The first leg of this journey took them along the Rhine to Cologne, where they ran into their first problem with train travel: the close connection.

"The train into Cologne was late — that's not supposed to happen," Ed says. "We had a close connection anyway, but this one was almost impossible. We did make the train — with four seconds to spare. We were on the vestibule when the train started."

Close connections like this one make traveling light imperative. All six carried only one suitcase apiece.

Besides enjoying mussels in Brussels and the famed *l'esprit ironique* of Brussels — the Mannekin Pis (it means exactly what you might guess), the group enjoyed a day train trip to Waterloo, also free with their Eurail passes.

HEY, MR. ANDERSEN! Tell us a story! Sandy McKay, Lu Neidel, and Betty Othmer rest their feet at the feet of the Hans Christian Andersen statue in downtown wonderful Copenhagen.

Unusual Vacation

CRUISING down the Sogne, the longest fjord in Norway, are (front) Lu Neidel, Sandy McKay, and Betty Othmer; (rear) Dick Othmer (ret.), Bob McKay, and Ed Neidel (2361).

Heading north to Amsterdam, the travelers encountered another problem with train travel: the train that doesn't cross borders. "We noticed a lot of people getting off at the border — right in the middle of nowhere," Ed says. "Finally the conductor came by and said, 'You belong on that train over there.' " They made another mad dash and got on just in time.

After a visit to Amsterdam's Rijksmuseum (which houses Rembrandt's famed *Nightwatch*) and the Van Gogh Museum, as well as the requisite canal boat ride, the group headed for Copenhagen with stops in Cologne to see the cathedral and Hannover to see the Herrenhausen Gardens.

On to Hamburg for dinner and to catch the night train to Copenhagen. They had reserved second class couchettes (a compartment with six bunk beds) for a small supplement, paid for in advance in Albuquerque.

Ed has several distinct impressions of Copenhagen. They had arrived in time for what Ed calls "a Mardi-Gras-like festival. Everyone was parading in the streets, all made up and dressed in costumes.

"All I can say is that I'm glad I'm not in the bra manufacturing business in Denmark," he observes.

Although Ed wasn't surprised at the size of the famous mermaid in the harbor (who did have both arms attached at the time of their visit), he was surprised at her feet. "They looked just like fish fins," he says.

They particularly enjoyed an evening visit to Tivoli Gardens, Copenhagen's world renowned amusement park. "Now I know where Walt Disney got the idea for Disneyland," Ed observes.

After another all-night train ride, the group arrived in Stockholm. They bought tourist passes at the railroad station for about $8 that gave them free admission to museums, free boat and bus tours of the city, and free rides on city transportation.

"It got to be almost a game to see as much with those passes as we could," Ed says. "We saw a lot more than we would have otherwise."

One of the most interesting sights was the *Wasa,* a ship built three centuries ago, which capsized on its maiden voyage. "It has no keel — the bottom is perfectly round. Maybe it capsized because everyone stood on one side at the same time," Ed chuckles.

From Stockholm, the travelers took a ship, the *Finlandia* (free with their Eurail passes), to Helsinki. "We liked Helsinki," Ed says, "but if we had language problems anywhere, it was there. We had an awful time getting oriented and started. We ran to get on a streetcar, and then got right off — it was the wrong one. The passengers must have thought, 'Those crazy American tourists!' "

On the train again, the group headed for Oulu, Finland, then on to Kiruna, Sweden. They crossed the Arctic Circle on the way to Narvik, Norway. "The Swedes built the railroad to Narvik so they could transport their iron ore," Ed says, "but the Norwegian railroad doesn't reach that far, so we had to take a bus farther south to pick up the train again. They took a side trip on a train to serious fjord country.

"The scenery was beautiful, spectacular — rugged mountains, lakes, fjords, waterfalls, cascades. It was so beautiful that we said — so help me — 'Not another waterfall, no more beauty, please!' "

When they finally got on the train that day, they were in for a surprise. "The beds were already made up. We thought it was mid-afternoon, but it was 10 p.m. The Land of the Midnight Sun can really play tricks on your internal timing."

Changing trains in Trondheim, they headed for Oslo, where they bought another free-admission tourist card. One of Oslo's sights that impressed them most was the Vigeland sculpture garden in Frogner Park. Norwegian sculptor Gustav Vigeland made a bargain with Oslo's city fathers: if they would pay his housing expenses for 30 years, he would create a sculpture garden for the city. And they did, and he did. The dozens of statues depict the human life cycle, showing a complete range of emotions.

From Oslo, the wanderers took the train to Myrdal, where they caught a hydrofoil (discounted tickets with Eurail passes), journeying through the longest fjord in Norway, to Bergen. From Bergen, they returned to Oslo by train, then went on to Gotenburg, Sweden, where they picked up a ferry to Fredrikshaven, Denmark.

From there, it was back to trains again — on to Frankfurt and the flight home, the end of a nearly epic journey.

In preparation, the three couples met about once every two weeks starting in January. They assigned a city to each couple to research. "That way you had somebody more knowledgeable and didn't have to read about each city yourself," Ed says.

Pass Mastery

As Ed Neidel (2361) attests, Eurailpasses can be an inexpensive way to get around Europe. Using them, however, requires some advance planning and a bit of specialized knowledge.

A Sandian (who prefers to remain nameless) tells about the first experience she and her husband had with Eurailpasses. "We were completely unprepared," she says. "We left for Europe with a return ticket, Eurailpasses, and Frommer's *Europe on $5 a Day*. Obviously," she adds parenthetically, "that was a long time ago.

"I remember getting nearly hysterical in every major city because of frustration — mostly with languages. In Paris, I was trying — with my nine-year-old college French — to make reservations on the boat train to London. The ticket agent couldn't — or wouldn't — understand me and signaled that I should step aside so he could wait on someone who had enough good sense to speak French properly.

"I could just see myself having to spend the rest of my life in Paris trying to learn enough French to get out. We did get out, however, and used Eurailpasses again the next summer with great success. We were prepared this time."

With a little preparation and advance knowledge, using Eurailpasses can be both an interesting and money-saving experience. The following list of suggestions is compiled as a result of several people's experience and is by no means exhaustive:

• Buy your Eurailpass here in the States (from a travel agent). You cannot buy passes abroad. The current price of a four-week, first-class pass is $410. Four-week, second-class passes are available only to students under 25 and cost $290. Passes are also available for periods of 15 days ($260), 21 days ($330), two months ($560), and three months ($680).

• Experts suggest that, to be economical, you should use your pass to travel at least 2000 miles during a minimum of 15 days. Side trips also make your Eurailpass a better buy.

• You can use Eurailpasses only in Western European countries. British Rail and Eastern bloc country rail systems will not accept them.

• If you plan to visit only one or two countries, you can sometimes buy national rail passes in the country you're visiting. For example, a France Vacances pass will pay for airport transfers, a Metropass good on Paris buses and subways (called the "Metro"), and admission to some museums — all in addition to rail travel.

• Eurailpasses are also honored for other modes of transportation: cruises on the Rhine and Danube Rivers, steamer cruises on Swiss lakes, and many international ferry crossings. For a complete list, check with your travel agent.

• Be sure to have your Eurailpass validated before you use it the first time. You will find a Eurailpass official in most large train stations, who will mark the first and last dates the pass is valid. If you wait to have your pass validated aboard the train, the conductor will do it, but he'll charge you about $5, and he probably won't be too happy about your interrupting his sometimes-hectic schedule. Keep your validation slip in a separate place because it's your proof of purchase in case your pass is lost or stolen. And keep your pass handy because you'll be asked to produce it often — every time the train personnel change.

• Travel light — one suitcase and flight bag per person. Often you must walk long distances in train stations to make a train change, and even if you don't have to run for a quick one, the walk can be exhausting.

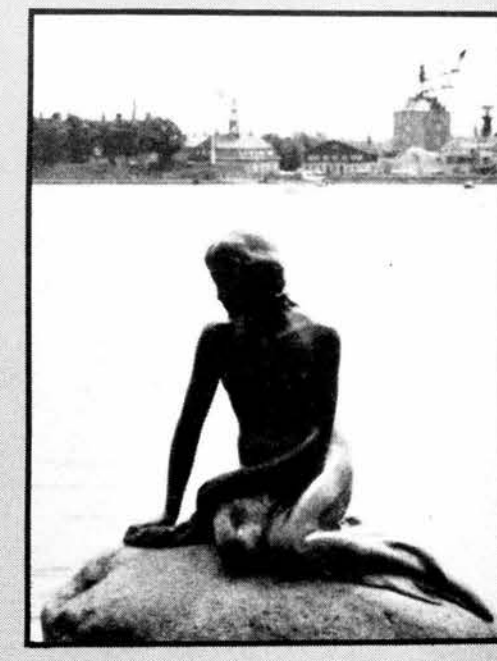
• A Eurailpass guarantees you a place on the train; it does not guarantee you a seat. If you want to make a seat reservation, you must do so 24 hours in advance. Occasionally, the reservations are free; other times there's a small surcharge — very much worth it to avoid standing with your luggage in the aisle of a train for two or three hours.

• Taking an overnight train saves on hotel bills, but it can be pretty exhausting to sit up all night even in a first-class compartment. For a surcharge (usually less than the cost of a hotel room), you can reserve a place in a second-class couchette. A couchette is a compartment with six bunk beds — which fold down into seats — stacked three high.

• Check the train schedules at least 24 hours in advance to make sure that your train leaves on the *day* you expect it to. Some trains don't run every day, and some schedules change in mid-season.

• If you don't have a reserved seat, make sure that the car you board is actually going to your destination. Each car's destination is posted outside that particular car. Some cars are dropped off in cities along the way, and you may find yourself sidetracked (literally) in a city you intended to avoid.

• If you do have a reserved seat, check the train diagram near your train's departing track to see where you car is located. Each car is numbered, but the numbers are not



necessarily sequential. You can save yourself a lot of steps if you have some idea where your car is. If you don't have a reserved seat, this diagram indicates whether a particular car is for smokers or non-smokers.

• Remember that Europeans use the 24-hour clock — no a.m. or p.m. Also, remember that, from our point of view, Europeans write dates backwards. We write June 5, 1985 as 6/5/85. In Europe, it's 5/6/85.

• If you have a traveling companion, have one person get on the train first and find the compartment. Then pass your suitcases through the train windows to your companion. You'll save yourself numerous bruises from carrying bags down the narrow aisles.

• Always carry water on the train. The water in the restrooms is not potable.

• Many trains have food carts which come by regularly, but many others do not, and fewer still have dining cars. Besides, the food you do get isn't very good and is almost always expensive. It's quite acceptable to have a big picnic in your compartment, and you may find yourself sharing treats with your fellow travelers.

• If you're planning a visit to several different countries, get about $20 of currency for each country before you leave. Even if you're planning to visit one or two different countries, it's a good idea to have some of that country's currency along. Often you arrive when banks are closed. In Italy, for example, banks are only open from 9 a.m. to 1 p.m. Exchanging money in places besides banks can be expensive. If you bring local currency with you, you'll be able to get a cup of coffee, a snack, and perhaps be able to shop around for a good exchange rate. The main office of Sunwest Bank (303 Roma NW) has an international currency window as does the insurance booth at the airport.

• Finally, be as well prepared as you can, but expect the unexpected, and if you can, try to enjoy it.

Take Note

Gerry Yonas, former Sandia Director for Pulsed Power Sciences, received the Fusion Power Associates' Leadership Award for 1984. The award, initiated in 1980, is given periodically to persons who have shown "outstanding leadership qualities" in guiding the evolution of fusion toward becoming a practical energy source. Yonas is currently Chief Scientist for the Strategic Defense Initiative Organization, Office of the Secretary of Defense. His award states that "Your scientific contributions and management actions have resulted in the cost-effective development of pulsed power technologies for fusion and national defense applications." Tihiro Ohkawa of GA Technologies was also an award recipient.

Previous FPA leadership award recipients are: Sol Buchsbaum, Executive VP at Bell Laboratories and former Sandia Research VP; Robert Hirsch of Arco Oil and Gas Co.; Congressman Mike McCormack; Senator Paul Tsongas; Edwin Kintner of GPU Nuclear Corp.; Howard Furth of Princeton Plasma Physics Laboratory; and John Emmett, T.K. Fowler, and John Nuckolls all of Lawrence Livermore National Laboratory.

* * *

Camp Fire Youth Services, a United Way Agency, is offering a summer day camp program for children of working parents.

Camp Okadana will be held at two locations for children ages 5 to 12 from June 3 through Aug. 23. Open from 7 a.m. to 6 p.m., Monday through Friday, the day camp provides lunches and snacks. Cost is $45/week with discounts for two or more children. Activities include swimming, weekly field trips, nature exploration, arts & crafts, drama and other creative activities, horseback riding, archery, and more. The two locations of the day camp are Montezuma Elementary School, 1616 Richmond Dr. NE, and U of A, St. Joseph Pl. NW. Pick up a registration form (due May 31) at the LAB NEWS office, Bldg. 814, or call 842-8787 for more information.

* * *

The NM Arts & Crafts Fair is seeking volunteers to help during the Fair, June 27 to 30, at the State Fairgrounds.

More than 400 volunteers are needed each year for sales, raffle and information booths; in the Youth Exhibit; and as ticket takers and cashiers. Shifts are for two to three hours from 5:30 to 10 p.m. on June 27, 10 to 10 on June 28 and 29, and 10 to 6 on June 30. To volunteer, call Tammy Mitchell, 888-4908; Donna Bryan, 821-8909; or the NMACF office, 884-9043 (Mondays or Thursdays, 9 to 12 noon).

* * *

The museums of Albuquerque are observing National Science Week (May 12-18) by joining in celebration of International Museum Day, May 18, to focus the public's attention on the wealth of information contained in museums. Museums in Albuquerque will participate by contributing to displays at Winrock Center and cooperating with Molly Trolly to promote a museum tour on that day. The museums hope to welcome first time visitors and to introduce them to the lure of visiting museums again and again.

* * *

A Special Award for Excellence in Technology Transfer was presented to five Sandians at a banquet and awards ceremony this week by the Federal Laboratory Consortium at its Spring Meeting held at Brookhaven National Laboratory in Upton, NY, May 6-9.

Carl Seager (1132), Dave Ginley (1154), Don Sharp (1831) and Janda Panitz (1834) received the award for their work in solar cell passivation (LAB NEWS, March 1, 1985); Pete Rand (1813) received the award for his work in aqueous foam (LAB NEWS, June 8, 1984).

* * *

If you'd care to see Don Meredith and Frank Gifford in roles other than the ones they play on TV's "Monday Night Football," travel to Santa Fe to see them in *The Odd Couple*. The two are helping to launch the 5th Anniversary season of The Santa Fe Festival Theatre by starring in this classic Neil Simon comedy—Meredith as Oscar Madison and Gifford as Felix Unger. *The Odd Couple* will be presented in 11 benefit performances from May 16 through May 26 at the Greer Garson Theatre at the College of Santa Fe.

A Gala Benefit has been set for opening nignt on May 17, with ticket prices at $25, or $100 for the perfomance followed by dinner and dancing with the cast. For the 10 remaining performances, ticket prices are $10 and $15 for weekday evenings and a Sunday matinee, and $20 and $25 for Friday, Saturday, and Sunday evenings. Tickets and information can be obtained by calling the Santa Fe Festival Theatre box office at 1-983-9400, Monday through Saturday, 10 a.m. to 5 p.m.

* * *

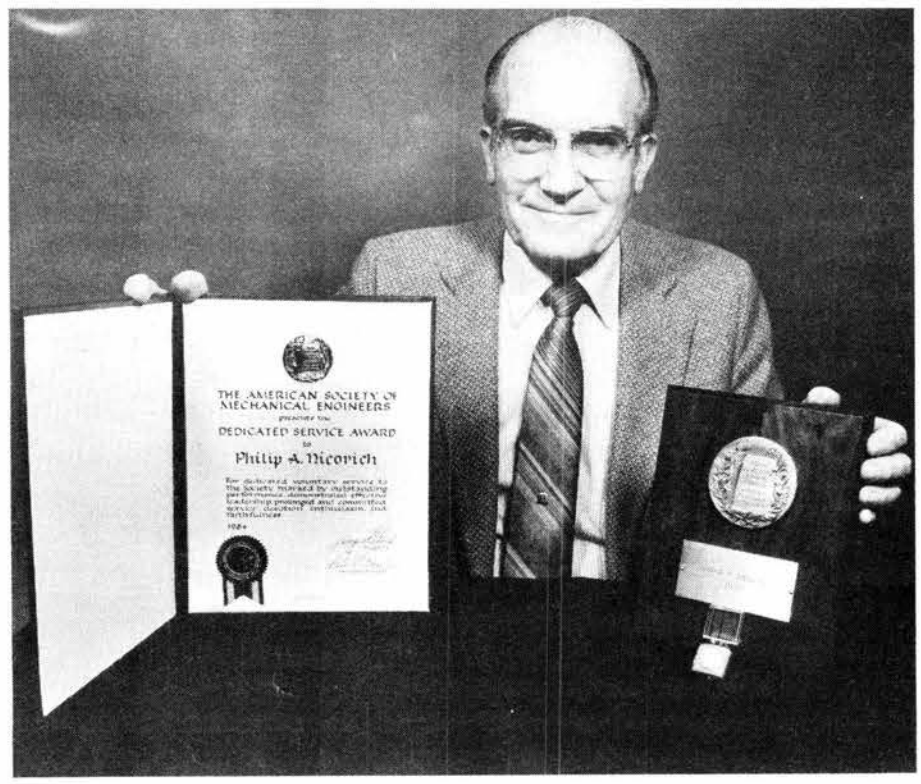
"The Ecology of a Lost World" is the title of a lecture/slide presentation, sponsored by the NM Museum of Natural History, on the bizarre discoveries of an international scientific expedition to the Cerro de las Neblinas (Mountain of the Mists), a 10,000-foot tepuis (giant mesa) that looms above the rain forests of southern Venezuela. The expedition found 14 new species of frogs, new species of snakes and insects, and many new species of plants. One of the least known regions on earth, the tepuis was first discovered in 1955. But rumors of strange life forms in the area inspired Sir Arthur Conan Doyle to write *Lost World*, which featured the discovery of dinosaurs atop a mountain surrounded by rain forests.

Expedition member Vickie Funk will present the lecture/slide show, preceded by the 1925 film *Lost World* (based on Conan Doyle's novel), at the Cochiti Room of the Convention Center, 7 p.m., May 15. Admission is $3 ($2 for foundation members, senior citizens, students).

* * *

"To serve well in tennis is not easy." That's the trenchant observation of retired Sandian Jim Hook in the new book he coauthored with former Wimbledon (and more) champ Tony Trabert. The book's called *The Serve: Key to Winning Tennis*, and it's quite enlightening to those whose view of serving in tennis is circumscribed: "You throw the ball up and hit it with your racket." Chapter titles indicate a more-than-casual analysis of the action: Tennis and the Serve, Preparatory Measures, Preliminary Motions, Propelling Actions, and Other Significant Considerations. For Hook and Trabert, good serving is to tennis what being dealt a good hand is in poker — you can go a long way with either a consistent three-of-a-kind or powerful serve.

The book is well-written and relatively free of the pretensions that afflict TV descriptions of tennis. It includes photos of Trabert demonstrating the various serves. Sandians seriously interested in the game will appreciate *The Serve*. Published by Dodd Mead, it's available in paperback at the LAB NEWS office for $7.95.



PHIL NICOVICH (2858) is the recipient of the 1984 ASME Dedicated Service Award. Phil was honored by ASME for his work with the Y-14.5 sub-committee, which is responsible for the national standards on dimensioning and tolerancing for engineering drawings. He has served as chairman of the subcommittee since 1966.

Reminder

Today is Fitness Day . . .

Emcee is Dr. Jarrett Galbreth...
Stretching demonstration...
1½-mile walk/run/jog; 3-mile bike ride...
Bob Banks Trio; Cloggers...
Pita pockets ($2) or bring your lunch...

At the Parade Ground from 12 noon to 1 p.m. . . .

Be a participant or a spectator...
Retirees and dependents welcome.

LYNN PETERS (3155) is a graphic design winner in the New Mexico Press Women's 1985 Communications Contest. She received a first place in the Black & White Advertising/Display category for the New Mexico Symphony Sponsor page, a third place in the Public Relations and Promotions category for her ECP campaign material (poster, logo, and newsletter), and an honorable mention in the same category for her Science and Engineering Fair poster.

UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

Deadline: Friday noon before week of publication unless changed by holiday. Mail to: Div. 3162.

Ad Rules

1. Limit 20 words, including last name and home phone.
2. Include organization and full name with each ad submission.
3. Submit each ad in writing. No phone-ins.
4. Use 8½ by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per issue per category.
8. No more than two insertions of same ad.
9. No "For Rent" ads except for employees on temporary assignments.
10. No commercial ads.
11. For active and retired Sandians and DOE employees only.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.

MISCELLANEOUS

SOLAR cover reel for swimming pool, new — in box w/warranty, $145. Kerschen, 821-2848.

FREE, female 2-yr. Lab/Collie w/doghouse, spayed, shots, housebroken. Lewis, 883-8454 after 5.

WHEELCHAIR, $100; walker, $25; maple table, seats 12, needs refinishing, $50. Jennings, 255-5950.

ETHAN ALLEN Classic Manor cocktail table w/beveled glass, new $700, sell $300; country French 9-pillow sofa, blue velvet, purchased Copperfields $1100, sell $500. Turpin, 299-7580 after 5.

Comptons Encyclopedia by Britanica, 26 vol. 1984 edition, new — still in box, $600, sell for $350. Chavez, 881-2711.

SAILBOARD, Obrien Blue Thunder, 12' planing hull, 65 sq. ft. Neil Pryde mylar fathead sail, vario-boom, vario-mast, retractable centerboard. Ritchey, 268-7620.

DINETTE set, 42" circular, lt. grey, wood grain formica, 2 leaves, 4 off-white vinyl chairs, $75. Bixler, 293-7205.

ORGAN, Kimball Temptation, 4 yrs. old, does everything. Kominiak, 898-4739.

BARBELL/dumbell set, 50 kilograms (110 lbs.), plastic covered weights, $20; weighted exercise shoes, $10; both for $25. Schkade, 292-5126.

TURNTABLE, Dual 1009, Shure M75E cartridge w/diamond stylus, $15. Erickson, 298-4416.

REFRIGERATOR, Frigidaire side-by-side freezer combination, 16.3 cu. ft., gold color, $240. Walter, 298-0471.

CLUTCH pressure plate for '69-'73 Datsun 510, $15; 510 engine & body factory manuals, both $7. Crow, 821-0956.

PUPPIES, ¾ German Shepherd, ¼ Husky, free to dog lovers, good home, or sell cheap. Marchi, 299-3610.

BUNKBEDS w/mattress; dresser; antique armoire; 19" color TV; Magnavox stereo; corner desk; 12-spd. bike w/infant seat. Chang, 843-9308.

CAMPER shell, insulated, fits LWB, first $225 takes it. Chavez, 831-9591.

UTILITY trailer, X-heavy duty, 5' wide, 10' long, 30" side boards, 14' overall, 4" channel construction, HD tires, 2"x8' flooring, $700. Wright, 296-3850.

TREE, nice and straight, for fire wood, swap for digging & carry away; furniture for sale. Sanchez, 298-4803.

KAYAK, Perception Eclipse, never used, floatbags, spray skirt, $575 new, sell for $450; Iliad paddle, $50. Shunny, 265-1620.

TWIN mattress & box spring set, new, $65. Paul, 299-6387.

GARAGE sale: camping equip.; tools; electronics; furniture; plants, etc., 1017 Jefferson SE, May 18. Patrick, 265-4569.

WINDSHIELD for Yamaha motorcycle, $35. Crawford, 883-5545.

ROCK climbing equipment. Boyd, 281-2275, 299-8523.

CAMPER shell, short bed, insulated, fits Datsun or small pickup, $225; Stenorette machine, tape-to-tape dictaphone, foot pedal, ear phone, $150. Carlin, 292-5428.

METAL shed, 9x10, parts & inst., $50; 3 tires, 195 R70 13, $40; 10-spd. bikes, men's, $20; women's, $35. Bray, 292-2410.

STEREO receiver, Pioneer SX-434, 30 watts, $50. Magnuson, 821-5330.

KENWOOD receiver, Pioneer turntable & 2-speakers, $200 OBO; Kenmore sewing machine, $75. Campbell, 296-5792.

QUARTERHORSE, 10 yrs. old, $600. Stone, 281-2819.

BICYCLE exerciser; stereos; ski boots; clothes; more, garage sale, May 11, 8-5. 9104 Matthew NE. Pafford, 298-8913.

STEREO, AM/FM cassette record player, twin speakers, $50; Artley B flat clarinet, $75; police scanner, 8-channel, AC or DC, $60. Gendreau, 268-3436.

SLEEPER sofa, 7½' long, $300. Baldonado, 836-5281 after 5.

TV Heathkit, GR-269, 18" color, solid state, 9 plug-in boards, complete set of manuals, $50. Pierce, 299-2801.

CARPET, 40 sq. yds., ivory color, used, Treadwell, 884-4221.

KOI (pond fish), sizes range from 6" to 15"; queen size mattress, box spring frame, $150. Navratil, 293-5527.

PIANO, vintage Lester brand spinet, mahogany finish, $900. Benson, 296-4282.

ANTIQUE 24" round table; Fisher Price doll house w/furniture; Vivitar 200mm lens (Pentax screw mount). Drotning, 294-4807.

REFRIGERATOR, frostless w/icemaker, coppertone, $175; Kroehler beige corner sofa, $175; Drexel dining room set w/buffet, $350. Kepler, 298-5652.

SINGLE bed, maple headboard, very firm mattress & box springs, $140 OBO. Saylors, 298-7377.

FREE Beagle, 2 yrs. old, fixed; triple dresser, full bed w/hd. & ft. boards, all $125 OBO. Harrington, 296-8208.

COMPUTER software, GW BASIC by Microsoft for IBM PCs & compatibles, documentation by Zenith-Heathkit, $125 orig., sell $30. Stevens, 299-6086.

GARAGE SALE, Saturday, 9 a.m., May 11, luggage, clothing, bikes, games, trundle beds, wigs. Cooper, 4405 Palo Duro NE.

LAWN MOWER, power reel type, Wards Gardenmark, self propelled w/grass catcher, $25. Randall, 299-3935.

SUNSHIELD for '79-'82 Datsun 310 hatchback, black aluminum, Kobel 4011, new, $100. Weber, 266-9100.

FREEZER, Admiral upright, white, $100. Curtis, 881-2440.

EXERCYCLE, Sears, w/odometer and adjustable padded seat, $60. Ahr, 883-0459.

OVAL dining table, traditional style, w/6 chairs, $300; 40-gal. gas heater, $25; bathroom mirror, light & cabinet, $10. Greenholt, 294-5286.

TRANSPORTATION

'51 FORD, best offer. Iverson, 865-4265.

'78 FORD LTD, yellow w/brown vinyl top, AC, AM-FM 8-track, 75K miles, $1600. Bailey, 298-1043.

'77 TOYOTA Celica GT coupe, 5-spd., CC, AC, AM-FM cass. stereo, rear window louvers, radial mags, $2600. Gomez, 821-0685.

'81 DODGE Aries K 4-dr. sedan, vinyl top, $2800. Chavez, 881-2711.

'72 TOYOTA truck w/overhead camper, sleeps 4, refrig., stove, sink, toilet, $4500 OBO. Aragon, 865-5395.

'71 OPEL, 2-dr., AT, sell as is $225 or sell parts; '73 Opel Manta parts, doors, windows, pressure plate, etc. Garcia, 888-4735.

'78 MONTE CARLO, AM-FM-8 track, PD, PW, PS, 46K miles, front-left bumper damage, $2000. Downs, 255-6524.

'79 HONDA 185-XL Enduro, $450. Heath, 869-2181.

'79 YAMAHA XS1100, fairing, rack, 2500 miles, shaft, one owner, new tires, $1675. Kimberling, 281-1932 after 6.

'74 MAZDA 4-spd., 2-dr., 53K miles, $1800 or reasonable offer. Villa, 298-0435.

'79 SEVILLE, fully loaded, low miles. Otero, 293-4462.

'82 ACCORD 4-dr. sedan, AC, PS, PB, AT, AM-FM tape, CC, extra M&S tires, 37K miles, $7300. Dawson, 281-1235.

'78 LAVERDA 1000, Silver Jarama, 12K miles, make offer. Wolfe, 298-6394.

10-SPD. bicycle, ladies Takara, $60 firm. Williams, 293-4115.

'69 CHEVY C-10 pickup, V8, AT, $1000. Brandon, 836-5621.

'74 DODGE Colt 4-dr. sedan, orig. owner, 30 mpg, $250. Bixler, 293-7205.

'82 KAWASAKI GPZ-558, Bell Star helmet, heated grips, extras, 2900 miles. Ritchey, 268-7620.

'83 YAMAHA XS650SK-B Heritage Special, 6K miles, plexifairing, backrest, new battery, helmet, $1500 OBO. Tapia, 298-0398.

'80 CHEVY Luv 4-wd pickup, AM-FM, AC, fiberglass shell, deluxe interior, 60K miles, $4500. Roseth, 822-0063.

'76 MUSTANG Mach I, V6, AT, PS, PB, AC, AM-FM cass., $1700 firm. Resnick, 292-3825.

'83 CHEVETTE Scooter, 4-spd., 18K miles, NADA retail $3525, sell for $3025. Weber, 293-7522 after 4:30.

'81 YAMAHA Maxim, 2600 miles. Burns, 821-0645.

CHEV. van, 1-ton, HD AT, AC, 4 captain's chairs, couch, radio/4 speakers, carpeting, airline ceiling lights, running boards, rack & ladder, frame trailer hitch. Dillon, 256-0076.

'77 VW van, new tires-paint-& upholstery, $3000 OBO. Armstrong, 298-4526.

'75 VOLKSWAGEN convertible, orig. owner, 88K miles, $5K. Gabaldon, 265-5991, 831-1541.

'72 DATSUN 1200, 4-spd., 2-dr. sedan, blue, orig. owner, $600. Grothaus, 821-1530.

MEN'S 3-spd. bike, 26" wheels, $35; variety of shop manuals for '71 Datsun 510. Jones, 299-9032.

'82 S-10 truck, 4-spd., Positraction, flatbed w/factory stake body, overloads, V6, 52K miles. Westman, 881-0471.

'78 SUBARU 4-dr., AM-FM stereo, $2000 OBO. Christopher, 299-5712.

'73 FORD F-100, 390 V8, AC, AT, locking diff., shell, dual tanks, $1550. Roberts, 881-2815.

'74 DATSUN B-210, 76K miles, new alternator-battery-regulator & starter, $825. Coughenour, 294-3528.

'78 CHEVETTE, AC, AT, silver-grey, low mileage, $1425. Newton, 255-2572.

'76 HONDA 400 four, windshield, luggage rack, $800. Dutler, 822-8285.

'82 PONTIAC Trans Am, red, T-tops, all options, low miles, one owner. Pierce, 265-0233.

'73 VOLKSWAGEN pop-top camper, new Michelin radials, new rebuilt Porsche engine, $2250. Davis, 298-1957.

'78 PONTIAC Sunbird, 4-cyl., PS, PB, AC, 39K miles, white w/red interior, $2600 OBO. Gendreau, 268-3436.

'81 RABBIT, 5-spd., 4-dr. hatchback, AM/FM radio, sunroof, $4500 OBO. Salazar, 836-2075.

'75 DATSUN 280Z, AC, 4-spd., $3650. Martinez, 898-0102.

'72 TOYOTA, $800. Ortiz, 897-2209.

SAILBOAT, day sailer, 15', fiberglass over mahogany, trailer, $600. Kendall, 298-2196.

'74 DODGE Colt wagon, 4-spd., manual, $450 OBO. Blejwas, 294-2057.

'73 FORD station wagon, AT, PS, PB, AC, luggage rack, $1000 OBO. Altwies, 292-3884 after 5.

'72 FORD Maverick, 4-dr., 75K miles, radials, AM radio, AC, PS, one owner, $900 OBO. Ratzel, 821-6368.

'74 MERCEDES BENZ 240D, air, sunroof, AM/FM, 91K miles, original owner. Carson, 281-5115.

'80 HONDA CB900, Custom 10-speed, fairing. 4600 miles, $1800. Johnson, 281-3083.

REAL ESTATE

TOWNHOUSE, 1400 sq. ft., 2-bdr., 3 baths, 2-car garage, extras, $5K down CTL $68,500, 12½%. Conklin, 821-6181.

3-BDR., 5 min. Elephant Butte Lake, new kitchen, fenced yard, 1¾ bath, fp, lg. carport & garage, $62,500 OBO, 10%. Gallegos, 294-0233.

10.5 ACRES, wooded, unimproved off S. 217, low down, assume 8.5% REC, $24K total. Kimberling, 281-1932 after 6.

ANGEL FIRE, .85 acre 300 yards from ski lift, $31K loan assumable, terms possible. Roseth, 822-0063.

3-BDR. house on .8 acre in Las Cruces. Mancini, 526-5603.

MOUNTAIN land, 10 acres, Cedar Crest area, adjacent to Sky Top subdivision & city park, $58K, terms. Kinney, 298-5281.

MH, 3-bdr , 2 bath, dbl. wide, '73 model, set up at Aztec MH Park, adult section. Chavez, 298-0674.

TOWNHOUSE, 2-bdr., 1330 sq. ft., 1¾ bath, 2-car garage, fp, NE heights, $81K, assumable CTL at 12¾%. Clement, 299-1501, 299-1542.

MH, '81 Redman Las Brisas 70x14, 2 bath, 2-bdr., lg. rooms, skirting, burglar bars, $19,500. Burkinshaw, 293-7563.

MH, 14x72 Lancer, 2-bdr., 2 bath, oak cabinets, pitched roof, wood siding, shingled. Aydelotte, 867-4143, 293-8581.

RESORT HOUSE on Rio Grande beachfront 2 miles from Elephant Butte, 2 stories, 3 bedrooms, 2 baths, 3 lots, $82K. Carson, 281-5115.

WANTED

BOY'S 20" bicycle. Locke, 299-1873.

HOUSING, faculty sabbatical needs furnished 2-bdr. or larger apt., house, or condominium, Aug. 15, 1985 to Aug. 15, 1986, non-smokers. Blackwell, 292-5362.

HEALTHY, adult cat that needs TLC; ladies 10-spd. bike. Hill, 299-5272.

OLD English sheepdog stud. Dalton, 873-0176.

GIRL'S Schwinn bicycle, 3, 5, or 10-spd., 20" frame, 26" tires, good condition only. Dale, 821-7117.

Mothers' Day Brunch Sunday

TONIGHT a variety group called Red Wine is on the bandstand from 8 to midnight. During the dining room hours (6 to 9 p.m.), the menu includes a two-for-one special — your choice of prime rib or rainbow trout, two dinners for $12.95. Reservations are not required after 7:30.

ON SUNDAY from 10 to 3, the Club wheels out an elegant brunch in honor of Mothers' Day. Entrees include eggs Benedict, prime rib, baked ham, and baked chicken supported by assorted sauces, juices, salads, fruit, vegetables, and desserts. Mama receives a free glass of champagne. Adults pay $7.95; children, $3.50. Bob Banks entertains on piano. Call 265-6791 right away for reservations.

NEXT FRIDAY, May 17, sees Jeanne Rich and Friends on the bandstand while two-for-one filet mignon or halibut at $12.95 is featured on the menu. This happens inside the dining room and ballroom area, meanwhile...

AN OPEN HOUSE happens on the patio from 4 to 7 p.m. An enticement for new members, the event is open to anyone employed on KAFB (Club members, too) and offers free beer and a spread of goodies while inspecting the soon-to-open Coronado Club pool and patio area. Special discounts are offered to new members who sign up at the party and pay a year's dues or sign a payroll deduction card for Club membership. Club annual membership fee is $60 ($5 monthly payroll deduction), but you can save $5 if you join at this event. The savings continue if you buy a pool and patio ticket at the same time. A single pool and patio ticket is offered for $10 (usually $12.50); couples tickets for $20 (usually $25); and tickets for a family of three or more, $30 (usually $37.50). The idea is for you to have a good time, enjoy the party, inspect the facilities, and save some money. The Club welcomes new members.

A TRAVEL PROGRAM on the British Isles is scheduled Monday, May 20, at 7:30 p.m. Thunderbird Travel will show an outstanding film and discuss travel in merry old England. There is no admission charge.

The Club office has information describing upcoming Club-sponsored trips: Las Vegas, May 26-29, $110; Disneyland, June 23-25, $202; Colorado, June 29-July 6, $299; and Canyon De Chelly, Oct. 20-21, $90.

THE CLUB CLOSES Thursday, May 23, to prepare for the annual retirees' picnic. There will be no luncheon service.

volunteers in action

Here are some current volunteer opportunities for employees, retirees, and family members. If you would like more information, call Karen Shane (4-3268).

CHILDREN'S COURT, Second Judicial District, Albuquerque, is seeking special advocates to monitor treatment plans in child abuse and neglect cases.

SHELTER FOR VICTIMS OF DOMESTIC VIOLENCE, a United Way affiliate, has recently moved to new quarters that have National Historic Site designation. A person with drafting skills is needed to document the present building as part of federally required master plan development.

NEW MEXICO SPECIAL OLYMPICS is a program of sports training and athletic competition for mentally retarded children and adults. Volunteers are needed to escort entrants to their assigned events at the annual state meet in Milne Stadium, May 17-19.

Sympathy

To Dan (7476) and Pat (7475) Appel on the death of their infant son, April 28 in Albuquerque.

To George Steigerwald (2346) on the death of his mother in Florida, May 4.

Events Calendar

May 11-12 — Iris Society Show, Sat. 4-7:30 p.m., Sun. 12-6 p.m., Albuquerque Garden Center, 881-3859.

May 12 — NM Symphony Orchestra Annual Mother's Day Pops concert at the Rio Grande Zoo, 2 p.m., 843-7413.

May 12 — Ceremonial Indian Dances at 1 and 3 p.m. every Sat. & Sun. during the summer. Indian Pueblo Cultural Center, 843-7270.

May 12 — Movietime at the KiMo, Movies by Great Directors: "Young Frankenstein," Mel Brooks (1979), 7 p.m., KiMo.

May 15, 17 — Lee Conors Dance, 8 p.m., KiMo, 766-7816.

May 17-19 — San Ysidro Fiesta in Corrales: food, vespers, entertainment, Mass at the old church, San Ysidro Church, 898-1779.

May 17 through June — "Tartuffe Tafoya," La Compañia de Teatro de Alburquerque. Fri. & Sat. 8 p.m., Sun. 3 p.m., Nuestro Teatro, 3211 Central N.E., 256-7164.

May 25-26 — Flower Show, open to any amateur grower or arranger; entries accepted May 25, 7:30-11 a.m. Open to the public May 25, 3-6 p.m.; May 26, 10 a.m.-4 p.m., Albuquerque Garden Center, 266-6656, 255-2529.

Fun & Games

Golf — Winners of the recent SGA "Rusty Wing" two-man scramble tournament played at Los Altos were Ron Inman (6515) and Mickey Shortencarrier (7223), first flight; James Clark (2313) and Danny Thomas (2314), second flight; and Charles Ringler (5261) and Larry Ritter (5242), third flight.

The next SGA tournament, an individual event, is scheduled tomorrow at Ladera.

* * *

Soccer — Sandia's summer soccer league play starts the second week in June, but deadline to register is May 17. Call Johnny Biffle (1523), 4-5385, if you're interested in fun and recreation — skill and experience are not necessary. Open to all Sandia, DOE, and contractor people of KAFB and their adult dependents, the teams have both men and women members. Games are played after work once a week.

* * *

Bicycling — Vern Duke (7862) writes that at 6 a.m. on July 21 "a band of desperados will be mounting bicycles and striking out from the Duke City for Lamy and its railroad station, intent on boarding Amtrak for the return trip." If you are interested in joining the motley crew for the 60-mile, do-it-yourself (no sagwagon), long-steep-hills tour, call Vern on 6-1800 for a flyer. Vern asked that the LAB NEWS "publish this notice early to give prospective desperados a chance to train"; thus Vern spoke.

* * *

Motorcycle Racing — The boondocks 20 miles out of Bernalillo off Highway 44 is the site of the eighth annual "Oh My God" motorcycle and three-wheeler desert race sponsored by S.O.R.E. (Southwest Off Road Enterprises) on May 19. A riders' meeting is at 8:30; the race begins at 9:30. The race has classes for experts ($1000 to winner), amateurs, beginners, women, and over 40s (experts ride 100 miles, amateurs and over-40s 75 miles, others 50 miles). Entry fee is $25 until May 14, $30 after. Trophies to first five places in all classes. Entry forms in LAB NEWS office. More information from Dwight Lewis (DOE/AL) on 296-7896.